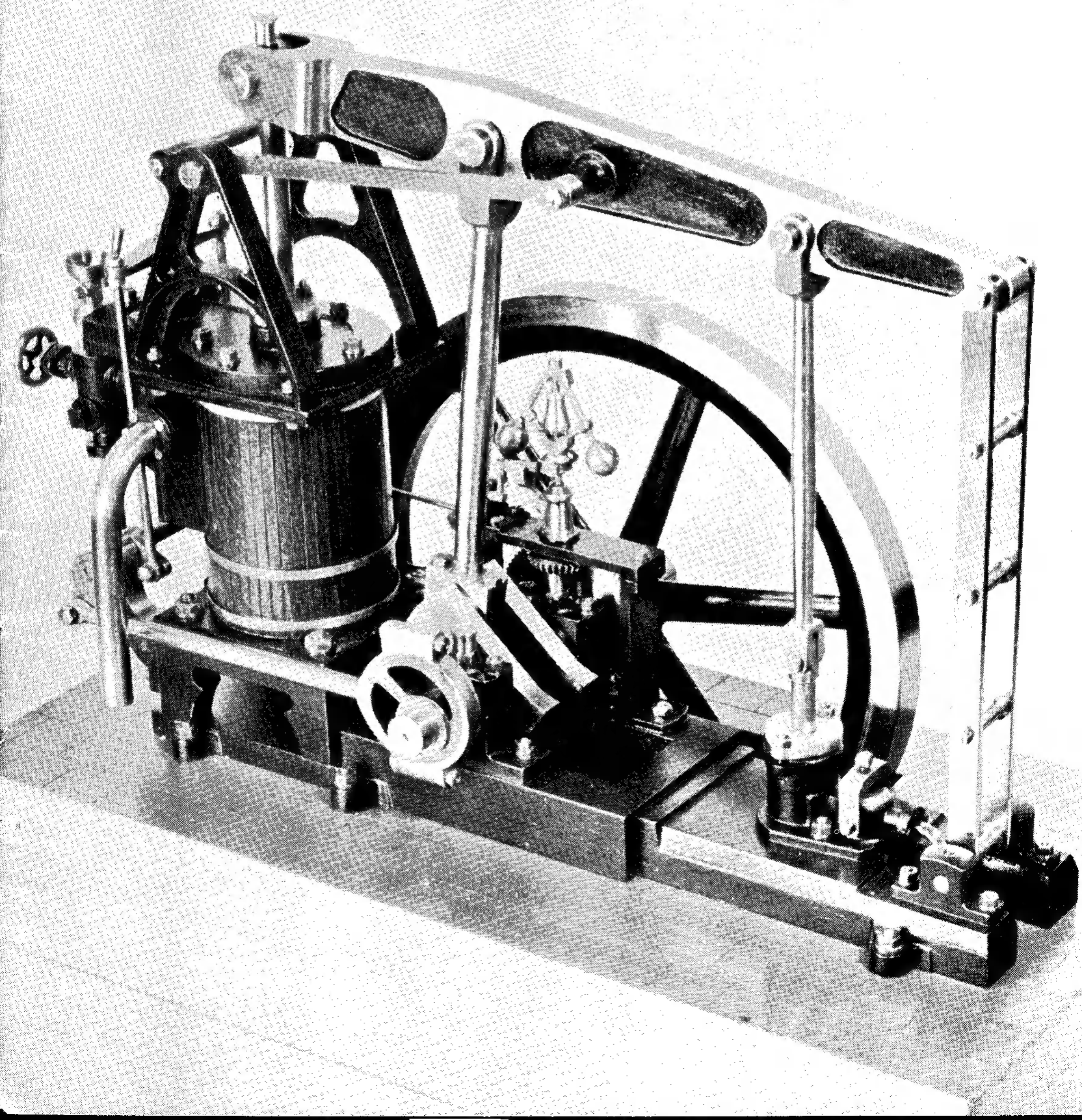
THE MODEL ENGINEER

Vol. 103 No. 2577 THURSDAY OCT 12 1950 9d.



The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

12TH OCTOBER 1950 VOL. 103 NO. 2577

Smoke Rings	545
The Rolls-Royce "Silver Ghost" ..	547
I Made a Lathe	549
Building an 0 to ½ in. Drilling Machine	552
The S.E. Association Regatta ..	556
For the Bookshelf	557
"Pamela"—A 3½-in. Gauge Rebuild of a Southern Pacific	558
A Simple Direct Current Circuit Breaker	563
A Cleansing Preparation	564
Petrol Engine Topics—A 10-c.c. Twin Four-stroke	565
A Double-acting Twin-cylinder Feed-Water Pump	569
Novices' Corner—Mandrels—Taper, Stub and Screwed	574
Queries and Replies	578
Practical Letters	580
Club Announcements	581
"M.E." Diary	581

SMOKE RINGS

Our Cover Picture

● THE MODEL of an Easton and Amos "Grasshopper" type beam engine depicted here was exhibited by Mr. H. J. Hawker, of Northampton, at this year's "M.E." Exhibition where it was awarded a bronze medal. It is built to a scale of 1 in. to 1 ft., and represents a type of engine which was popular in moderate and small power installations about a century ago, the makers of this particular prototype being well known for all types of beam engines. As distinct from the orthodox form of beam engine with the fulcrum in the centre, the "grasshopper" beam, pivoted from a swinging link at one end, allows of greater compactness for a given length of piston stroke, besides simplifying the design of the parallel motion and reducing the inertia of the working parts. This type of engine is fascinating to watch in motion and is very popular among lovers of old-time steam engines, many of whom have asked for further particulars of this model. For their benefit, it may be observed that a constructional article on a practically identical model, by Mr. A. Ebeltoft, of Norway, appeared in the issue of THE MODEL ENGINEER dated March 31st, 1949; this included fairly complete working drawings, the dimensions of which are in metric units, but could quite easily be converted to inches and fractions.

The Old Oak Common M.E. Club

● FROM A letter which we have received from Mr. A. J. Beer, of West Drayton, there seems to have been some reorganisation of model engineering activities at Old Oak Common, but the society there is still going strong and continues to attract new members. Incidentally, there has been, after all, no change in the title, which is: "The Old Oak Common Model Engineering Club." Mr. A. J. Beer is hon. secretary; his address is 61, Warwick Road, West Drayton, Middlesex, and the club is open to anyone who cares to join.

A Prize Declined

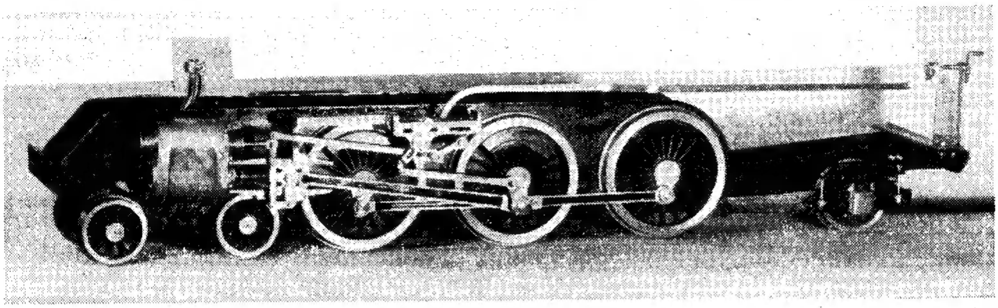
● WE HAVE been asked to announce that Dr. F. Machanik, whose fine model of an ocean-going steam tug won the Wellingham Cup at the "M.E." Exhibition, has declined, for purely personal reasons, to accept the award, and has suggested that the prize be held over for next year's exhibition, to be awarded anew.

Apologium

● WE OWE a sincere apology to Mr. F. G. Lemont whose ¾-in. scale G.N.R. Atlantic locomotive was described in our issue for September 21st. This interesting little article was published without any mention of its author's name, through some extraordinary inadvertence

Quick Work

● MR. E. HOYLE, of Bradford, must be a more than ordinarily rapid worker, judging by the photograph reproduced on this page. This locomotive chassis, which is for a 3½-in. gauge *Pamela*, has been built entirely in spare time in just over three months.



Mr. Hoyle says that his age is 49; the tools used for the chassis were a 4-in. Union lathe and a home-made drill; in addition, several dozens of hacksaw blades and cups of "engineman's best" were disposed of! Mr. Hoyle adds that the first run with this chassis was made, in the presence of his small daughter, nine weeks after construction was begun; the power was supplied by compressed air from a home-made compressor. He hopes to run it from its own steam very soon. We imagine that, from the excellent progress made so far, the whole engine will be finished by Christmas.

Sugar Machinery

● AT THE 1938 Empire Exhibition in Glasgow, there was a very fine model of a sugar plant. It attracted a great deal of favourable comment from visiting model engineers, and several were heard to forecast that their own efforts would lead them in a similar direction.

Having made enquiries of late, all of which have led nowhere, we have come to the disappointing conclusion that there must indeed be few, if any, such models in existence. Yet, here is a subject full of fascinating possibilities, one that would bring to the fore all that is best in model engineering. We would be pleased to hear from any readers who may know of the existence of models of sugar machinery.

British Standard Locomotives

● THE RAILWAY EXECUTIVE has lately issued an announcement that the first standard locomotives for British Railways will go into production this autumn, and will be in service early in 1951. Of a possible twelve new standard types with which it is intended eventually to cover the work of the present range of four hundred different designs, six will be represented in the 1951 programme, all of them in the "mixed-traffic" category. One hundred and fifty-nine engines are on order, comprising: 25 4-6-2 tender engines, Nos. 70000 to 70024, designed at Derby, built at Crewe and divided between the Eastern and Western Regions; 10 4-6-2 tender engines, Nos. 72000 to 72009, designed at Derby, built at Crewe and allocated to the Scottish Region; 30 4-6-0 tender engines, Nos. 73000 to 73029, designed at Doncaster, built at Derby and allocated to the Scottish and the London Midland Regions; 20 4-6-0 tender engines, No. 75000 to 75019, designed at Brighton, built at Swindon and divided between the Western and the London Midland Regions; 54 2-6-4 tank engines, Nos. 80000 to 80053, designed at Brighton, built at Derby and Brighton and divided between the Scottish, Southern, North Eastern and the London Midland Regions; 20 2-6-2 tank engines, Nos. 82000 to 82019, designed and built at Swindon for use by the Western and Southern Regions.

It is interesting to note that, for the present at any rate, preference is given to the general-utility classes of locomotives; we are informed that the designers have been working for two years on plans for the new engines, and the best practices of all Regions have been studied with the object of embodying in the new engines the maximum ease of access for servicing and repair; economy of coal consumption; a very considerable degree of interchangeability of parts; increased mileage between repairs, and an adequate reserve of power for traffic requirements.

We shall await, with interest, the publication of the particulars and illustrations of all the new types, and opportunities of observing their performances, as compared with those of existing types.

A Good Idea

● AT AN agricultural show, and a very big one at that, held at High Wycombe recently, one of the focal points of interest was the model engineering tent, which housed a selection of excellent models constructed in the main, by members of the High Wycombe and District Society of Model Engineers.

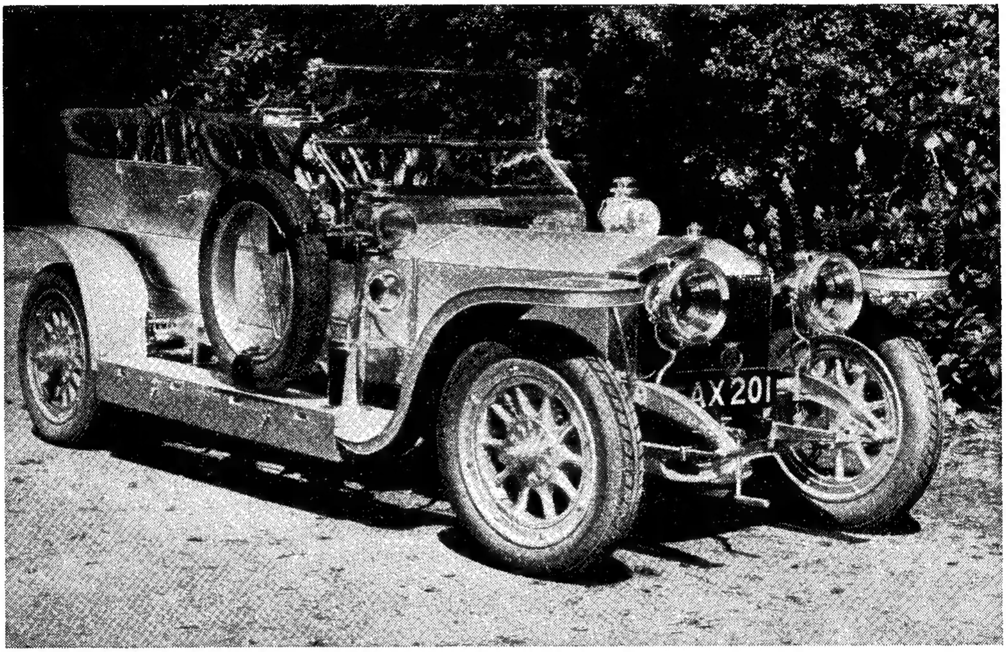
This is an excellent method of bringing our hobby to the notice of would-be participants, and it is hoped that other societies will give due consideration to similar activities in their respective districts.

A Proposed Uckfield Model Engineering Society

● MR. C. H. E. MOORE, of 6, Lewes Road, Ridgewood, Uckfield, Sussex, has requested our assistance in getting in touch with local model engineers, with a view to forming an Uckfield and District Model Engineering Society.

THE ROLLS-ROYCE "SILVER GHOST"

by C.W.M.



RE the illustration of the scale model 1907 Rolls-Royce " Silver Ghost " on page 240 of THE MODEL ENGINEER for August 17th, 1950, readers may be interested in further details of the past and present history of the original of the model, and a few interesting facts concerning early Rolls-Royce cars.

The model shown is a true-scale model of the original " Silver Ghost " registered No. AX.201, in the condition in which it was delivered to its owner in 1907. It remained in his ownership for over 40 years, during which time it covered over 300,000 miles in the manner expected of a product bearing the illustrious name of Rolls-Royce.

It has recently been re-acquired by the company, and a thorough inspection revealed the chassis to be in remarkably fine condition. The car was reconditioned, principally externally, all bright fittings being silver-plated, the coachwork paint being aluminium. The photograph reproduced above shows the car in its present condition. The main changes made by the one owner, and revealed by a comparison with the model, show that a three-piece adjustable windscreen replaces the original flat type, and a set of detachable rims grace the roadwheels, with a spare rim in place of the original pair of " Stepney Wheels." This latter weird arrangement, completely unknown to the modern school of motorists, provided a spare rim with tyre and tube, having a set of clamps for attaching to the *side* of the wheel having a punctured tyre. When fitted to a front wheel, the steering was not exactly improved, as one can well imagine !

The acetylene headlamps, with " submerged " type generator on the off-side running board, will be noted, and also the oil side lamps. *Two* magnificent examples of the classic " boa constricter " bulb horns are carried ; their sonorous, prolonged " moo " being in pleasant contrast to the modern strident blast.

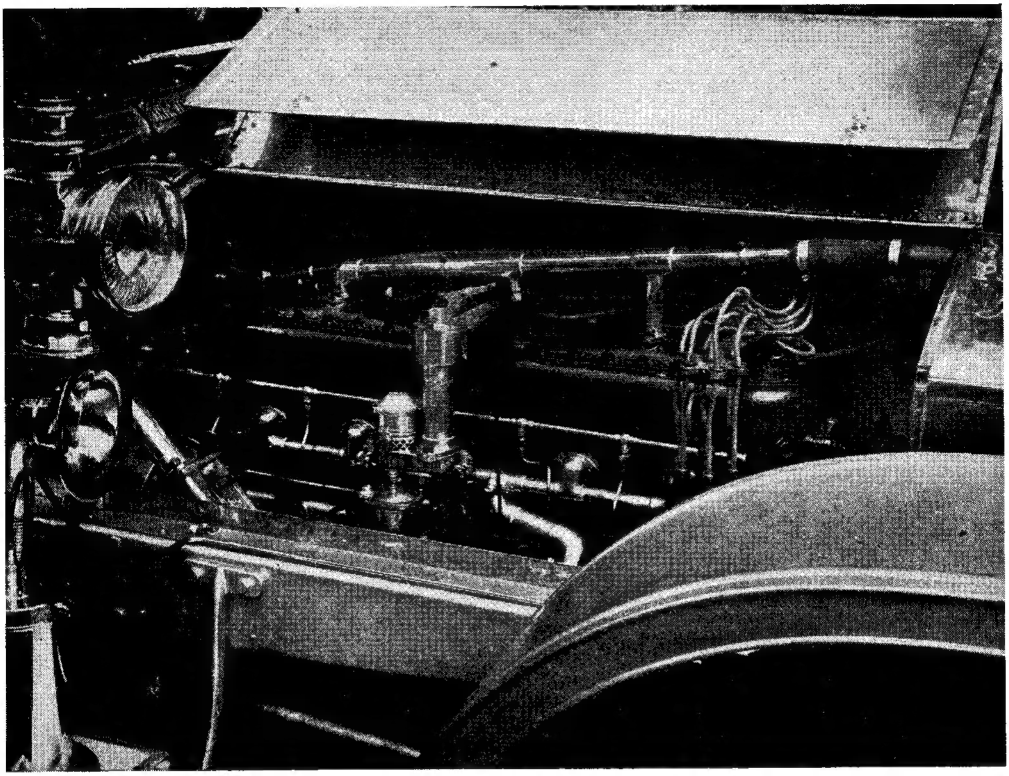
On a recent run from London to Derby it proved capable of speeds considerably over 60 m.p.h., and whilst cruising in overdrive, high road speeds with moderate engine speeds gave fuel consumptions around 14 m.p.g., and almost complete absence of engine noise.

No electric starter or generator was incorporated, but this, strangely enough, was not as terrible a drawback as one would imagine. The ignition system employs complete dual ignition, a magneto serving one set of spark plugs, whilst the second set of plugs is fired by a coil system embodying a trembler coil. The precision fit of the cast-iron pistons, which carried *six* piston rings each, plus the accurate fit of the valves, ensured that, if one was crafty enough to stop the engine in the right way, a charge of gas would be retained, even overnight, and starting up was simply a matter of switching on and moving the spark lever to retard.

Gearchanging is tricky by modern standards, but specialised instruction on this and all other aspects of driving and maintenance were considered necessary and the firm has maintained an efficient private school for the benefit of users for the past 40 years.

Ghost" are in daily use, and will be for many years to come, albeit in the humble roles of funeral hearse and garage emergency breakdown outfit.

Should an urge exist to go even further back, the South Kensington Science Museum houses one of the earliest Rolls-Royce cars, a 10 h.p., 1904 two-cylinder. "The first ever" Rolls car, also a 1904, 10 h.p., two-cylinder, is owned by the company, and is still in excellent running order. It was used as the late Sir Frederick Henry Royce's personal car until the 1920s, and it was with difficulty that he was persuaded to use a bigger, more modern model.



Offside view of 1907 " Silver Ghost " engine. Points of interest are the semi-expanding carburettor with piston-type throttle, extra oil valve and distributor pipe for high-power running ; coil ignition distributor top and leads, oil side lamp and boa constrictor horn flare

The cooling system incorporates pump circulation, and the carburettor was a two-jet expanding type with piston throttle. The six-throw crankshaft is carried in seven bearings, and the lubrication system, even by modern standards, would be classed as complete, and even incorporated an extra oil feed for the pistons, brought in automatically when conditions called for it.

The cylinders were made in two blocks of three, with side valves and non-detachable heads. The main features of interest on the off-side can be seen in the above picture.

It is of interest to note that the same basic chassis was in continuous production from 1907 to 1925, apart from a short period during World War I, and that this same chassis with stronger springs, was the famous Rolls-Royce armoured car chassis, the history of which forms a classic in its own right.

For those who feel an urge to make a scale model of this world-famous car, it is a happy thought that many fine examples of the " Silver

Between the years 1904 and 1907, Rolls-Royce cars of two-, three-, four-, six- and even Vee eight-cylinder arrangements were produced in limited numbers from Cooke Street, Manchester, and were acknowledged to be masterpieces of automobile engineering. It was, however, the decision to concentrate on the six-cylinder " Silver Ghost," and the move to a new, modern factory at Derby, which permitted the necessary increase in production, together with continuous development, which laid the foundations of the present organisation, and to so spread the fame of the " Silver Ghost " that by 1914, the name of Rolls-Royce was looked upon the world over as indicating the superlative.

*I Made a Lathe

The History of the Manufacture of a 4-in. Centre Lathe

by A. H. Poole

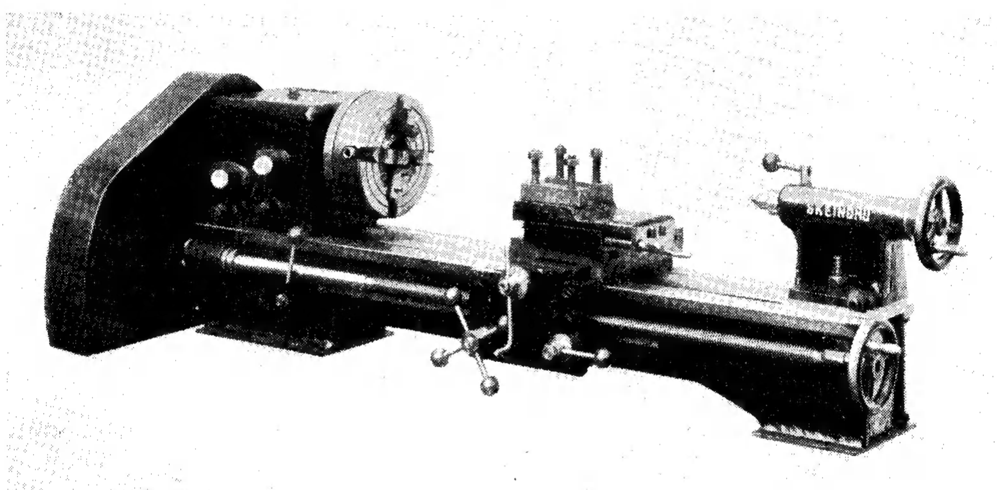
I WAS able to contact a foundry through the advertisements in THE MODEL ENGINEER, and all the initial castings were carried out to my satisfaction by this firm. Later I made use of my friend the moulder. Progress was held up by the long delays which were being experienced at that time by goods traffic on the railways. Nevertheless, it was just over three months from first drawing the design until I bolted the casting for the saddle to the table of the milling machine. It may appear to be an unusual place for starting to make a lathe, the reason being that I was having difficulty in getting that 0.4 per cent. carbon-steel for the bed plate.

Removing the Patch

The castings for the slide rest and accessories were rough machined without difficulty, except that one had a very hard patch on the skin. I experienced trouble when removing this patch, for it was so hard I had to continually renew the chisel edge. The castings were finished and milled, and the internal thread for the Acme leadscrew was cut by means of the 8-in. lathe. The thread was finally trued up by means of a tap. All surfaces were bedded flat to a surface plate and by using a parallel ground steel bar as shown in Figs. 9 and 10, the dovetails were checked for parallel. The dovetail slide fitted on all surfaces, there being a fitting strip inserted between the sloping sides.

The Bed

By the time I had finished the apron and slides, the material for the bed had been obtained. The various pieces were cut to shape and the whole held by temporary tacking until the bed was completely welded. I allowed $\frac{1}{4}$ in. on the bar for the shears, for machining purposes, and this proved to be just sufficient. Naturally, I could not machine this bed on the miller, so I approached a local engineering firm who concentrated on the manufacture of jigs and tools. I explained to them that I wanted the bed machined, then I would collect it, flame-harden it myself and return it to the works for finish grinding. Unfortunately, the fuel crisis interrupted at this stage, and to complicate matters I moved my abode some 400 miles. It was not surprising, therefore, although disappointing, that when the bed arrived it had been both machined and ground without hardening. It was a beautiful job even so. I remember the grinding machine which had done the finished grinding. It was of American manufacture, a pleasure to behold and its accuracy was remarkable. I was therefore, in possession of an accurately machined bed made of an unsuitable material. In addition, I had many machined parts for the lathe but nowhere to get working on it.



A three-quarter view, showing compound rest and large area boring table

Work on the New Lathe

I soon got permission to use a large cellar which is my present workshop. Work on the lathe was held up whilst I rigged up the overhead shafting and fixed up my power drill and tiny 3-in. lathe. Work was then resumed on the new lathe. I

*Continued from page 513, " M.E.," October 5, 1950.

had been getting delivery of the remaining castings and material whilst the new workshop was being arranged, so I mounted the bed in a suitable position and proceeded to erect the headstock. The casting had eventually proved

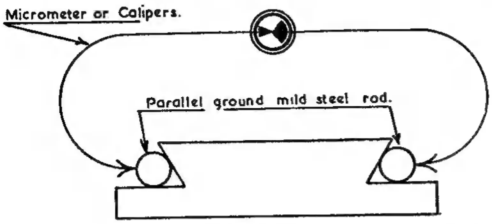


Fig. 9. Checking male dovetail slide for parallel

satisfactory and it was filed to shape. The spindle and intermediate shafts had been turned and ground on the 8-in. lathe so, excepting the gear wheels, the problem here was confined to assembly. The cutting of the gears was entrusted to a commercial firm who did the job well. After the various parts had been fitted together and the countershaft on the back of the lathe had been erected, the headstock was fitted to the bed, and a trial run found that the gears ran quite silently and the range of speeds was suitable. I might add here that I have since found that twelve speeds are not needed on a lathe of this type. They are merely a luxury.

Much Filing and Scraping

As I now had the new lathe connected to the overhead shaft I could no longer use my old lathe, so this was disposed of and by a temporary

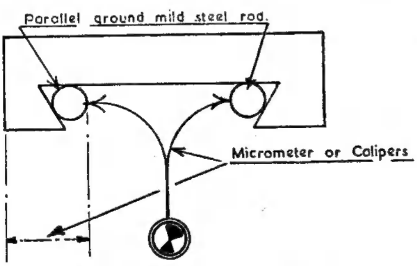


Fig. 10. Checking female dovetail slide and cross-slide sides for parallel

rig of the leadscrew I was able to turn the remaining parts for the lathe and bore the tailstock. I had much filing and scraping to do before the tailstock was finally fitted. I then finished off the remaining odds and ends such as handwheels, and completed the leadscrew and half-nut, also the quick traverse for the apron.

Accuracy

I was all set now to line up the machine to the required degree of accuracy. The cross-slide was the first job to be set square to the longitudinal axis of the bed. The set-up was as shown in Fig. 11. A clock gauge was fixed to the spindle by means of a toolmaker's vice and short arbor. The side of the boring table of the cross-slide had been checked to make sure that it was parallel with the slides. The cross-slide was moved as far over as possible and the clock gauge set. The error to the square was easily read as the boring table moved across on turning the appropriate handle. The cross-slide was dismantled and the desired amount filed off the positioning strip underneath. This was repeated until no deflection showed on the gauge. The next job, to line up the headstock, was carried out by making use of a jig consisting of a parallel length of bar terminating in a No. 2 Morse taper shank. This was inserted in the spindle and the clock gauge set up attached to the toolpost, to give the result shown in Fig. 12. By moving the toolpost up and down the bed,

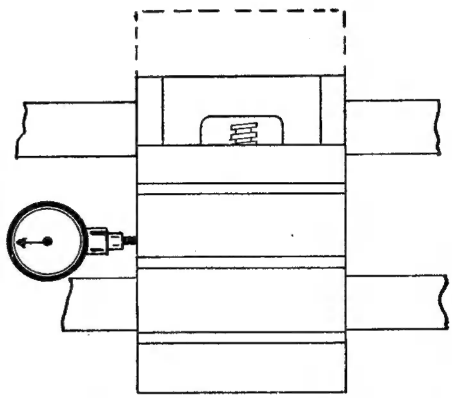


Fig. 11. Checking cross-slide for square with bed slides

the amount of inaccuracy in alignment was indicated by the deflection of the clock gauge. Once the spindle had been lined up in this manner the procedure was repeated with the clock gauge arranged in a vertical position so checking that the spindle was not lying down in the vertical plane. The tailstock was lined up and a mark made to indicate centre by roughly the same means. The exception was that the bar located in the spindle nose was replaced by a parallel ground bar centre drilled at each end and mounted between centres. Figs. 13 and 14 show the operation as carried out in horizontal and vertical planes.

Guards

The lathe was completed by the addition of guards over the screwcutting gear chain of wheels; a coat or two of paint was applied, with the name picked out in white. I was a little in doubt as to how long the unhardened steel shears would last, but it has been in service quite a considerable time now and no scratches are in evidence, although I must admit that extreme care is taken to avoid

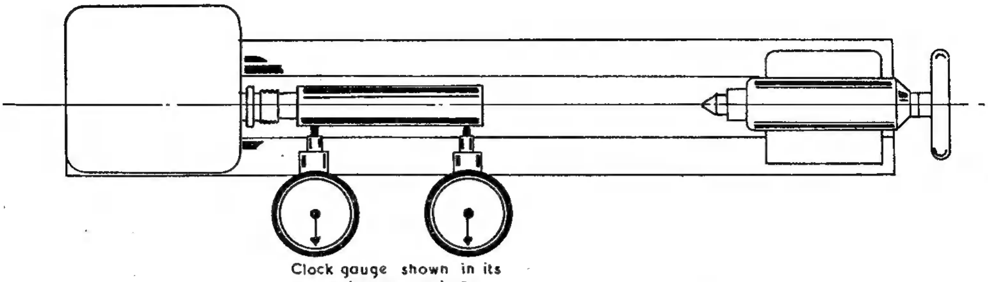


Fig. 12. Checking alignment of headstock spindle

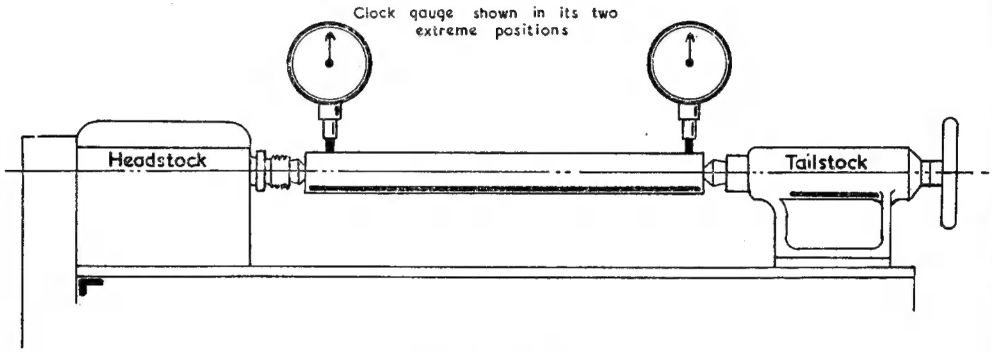


Fig. 13. Checking height of tailstock

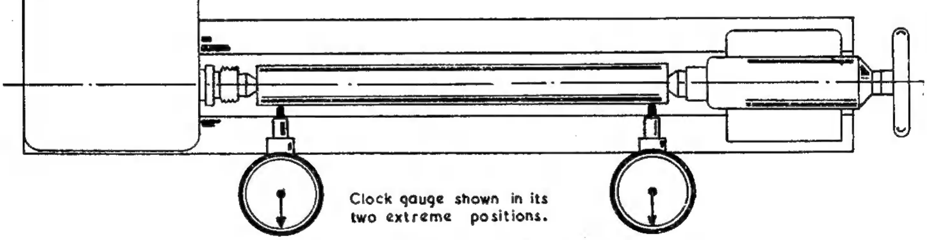


Fig. 14. Lining up tailstock to headstock centre

the entry of small cuttings between the two sliding surfaces. Almost as soon as the machine was complete I started to be dissatisfied with the bed, purely because of the unhardened slides. I therefore got busy on a new design of bed made from cast-iron. I arranged the pattern so that it was cast upside down. This makes as sure as possible that the most important part of the bed, that is the top, is subjected to the highest pressure in the mould. This tends to force out any air bubbles and the like. The pattern in a complete state now lies in my workshop, ready for use as soon as the existing bed shows signs that it should be replaced.

Now that the lathe is finished I have a very pleasant sensation of achievement whenever I take a good look at it. I am, nevertheless, still dissatisfied, for I want to equip the machine with a vertical slide and a milling attachment before I can really call the job complete.

Finally, if any reader is sufficiently interested in my effort to desire a set of castings off my patterns, I would be pleased to hear from him and to give him assistance if required.

Building an 0 to $\frac{1}{2}$-in. Drilling Machine

by "Midlander"

THE main factors which started me building machines were the acute shortage of same and excessive prices during the war years, and as I believe in the old saying that neither wise men nor fools can work without tools, I decided that if I could not buy them I could at least have a try to build them.

At this time my workshop drilling facilities consisted solely of a hand-drill and a bench type hand-drill, the latter being an excellent machine and continually in use until the completion of the electrically driven machines described here. The first attempt was a huge success and was a machine with a capacity of 0 to $\frac{3}{8}$ in. This was built up mainly from scrap, and is now hard at work in a workshop of one of my fellow model enthusiasts and he says it is as easily capable of drilling $\frac{3}{8}$-in. holes as $\frac{1}{16}$ in. and less. The drill has been used for many years now, and the only trouble experienced so far has been with the centrifugal start mechanism on the motor which is of the $\frac{1}{4}$ h.p. type. As I knew this type of design to be very reliable I set about designing a slightly larger model, incorporating several modifications which I thought necessary, working from experience gained in constructing the previous machine.

The first step was the cutting of material for the head and this consists mainly of two pieces of pipe and two pieces of plate. The pipe for the drilling spindle was 2-in. bore and 8-in. long while the one for the column was $4\frac{3}{4}$ in. long and 2 in. bore. The two pieces of plate were of 3 in. × $\frac{1}{2}$ in. section and were $10\frac{3}{4}$ in. long. This whole unit was clamped together and welded so that the pipe centres were 9 in. As the column was of 2 in. diameter, this gave the distance of 8 in. from chuck centre to column, which I considered ample. This unit need not be welded, but can be studded together by means of eight $\frac{5}{16}$-in. Whit. studs for the benefit of readers without welding facilities. The spindle tube was bored clean after welding of this unit and the column tube filed in places so that the 2 in. diameter column was a good fit inside this. By "bored clean" I mean that only the smallest amount was bored out of the spindle tube to allow for the smooth travel of the quill, which is the casing enclosing the rack and bearings for the drill spindle. This was not made, of course, until later.

The motor plate was next cut from a piece of $\frac{3}{8}$-in. plate and measures 7 in. × 5 in. To this plate were welded two U-shaped pieces which fit either side of the drill head unit. These pieces were bent in the fire from $\frac{1}{2}$ in. sq. steel and the distance between the two legs of the U is $\frac{5}{8}$ in. They were cut to length after bending and were driven into $\frac{5}{8}$-in. holes, drilled in the motor plate after the ends were filed, the whole being welded together in a very rigid unit. The reader will see that the reason for this assembly is mainly to give an adjustable belt tension to the motor. There are several methods of doing this and an alternative is given in Fig. 3. The hole in the head for the motor plate to bolt to and the holes in the motor plate for motor were not drilled until later as I was not definitely sure of the sizes of the belt pulleys I would use.

A piece of brass was next obtained to make the housing for the top bearing, which was a standard ball race, type BRL $1\frac{1}{4}$ in., $2\frac{3}{4}$ in. o.d., $1\frac{1}{4}$ in. bore and $\frac{11}{16}$ in. wide.

The brass was $3\frac{1}{4}$ in. diameter by $1\frac{3}{4}$ in. long and was bored to drive over the top of the spindle tube. This bore was opened out for $\frac{11}{16}$ in. to take the bearing and after assuring myself that the bearing would go, I fitted the brass unit, less bearing, to the head of the spindle by means of three $\frac{5}{16}$ in. diameter studs. Two holes of $\frac{3}{8}$ in. diameter were next drilled in the 3 in. × $\frac{1}{2}$ in. bars of the head, for bolting the bar, on which is mounted the feed-handle bearing. Holes were also drilled and tapped $\frac{3}{8}$ in. Whit. in the column tube for securing the complete head to the column.

The column is a piece of 2 in. diameter bright mile-steel and is 2 ft. 6 in. long. Should the reader require to build a machine he must carefully ascertain the general sizes of the work he wishes to drill and must then determine the maximum distance of table to check which he is likely to require. This may mean a longer column and I found that it is better to buy a long piece of shaft and build the machine to your own requirements. I have since changed my 2 ft. 6 in. column for a 5 ft. 3 in. long one, and this has converted the bench machine to a floor type. There does always seem to be a job where the bench machine is useless and then you are pleased you have decided on the model with the longer column.

The next parts cut were the two pieces of round steel for the table arm and the bar to be welded between these. The round mild-steel for the column was turned 3 in. outside diameter, 3 in. long and 2 in. bore a good sliding fit for the column. The other round was 2 in. diameter and $2\frac{1}{2}$ in. long and this was not bored yet. The bar for welding between the two was of $1\frac{1}{2}$ in. × $1\frac{1}{2}$ in. section and was cut to make the distance between centres of the two rounds the same as the head, this being 9 in. After welding, the tube which fits the columns was drilled and tapped $\frac{5}{8}$ in. Whit. to take the screw of the handle which clamps it securely to the column, and also allows the up and down movement of the table arm when necessary.

The baseplate was next cut from $\frac{1}{2}$-in. plate and measures 20 in. × 12 in. Secured to this by means of four $\frac{1}{2}$ in. Whit. studs is the holder for the column base. This was turned from an old lathe faceplate originally, but it has since been replaced by a casting from a local foundry. The

column is a good fit in the bore of the casting, but it is firmly secured by a $\frac{1}{2}$ in. Whit. Allen screw. Four holes of $\frac{9}{16}$ in. bore were drilled in the baseplate for securing same to the bench by means of $\frac{1}{2}$-in. bolts.

The quill was the next job tackled and was turned from a piece of $2\frac{1}{4}$ in. diameter mild-steel, which, after fitting, was tacked at either end by welding. This quill was further machined on the miller for the $\frac{5}{16}$ in. $\times$ $\frac{3}{16}$ in. deep slot straight through to take a stud later fitted to the spindle tube. It will be seen that this is to prevent the quill from revolving and can be used for securing same in a given position if required.

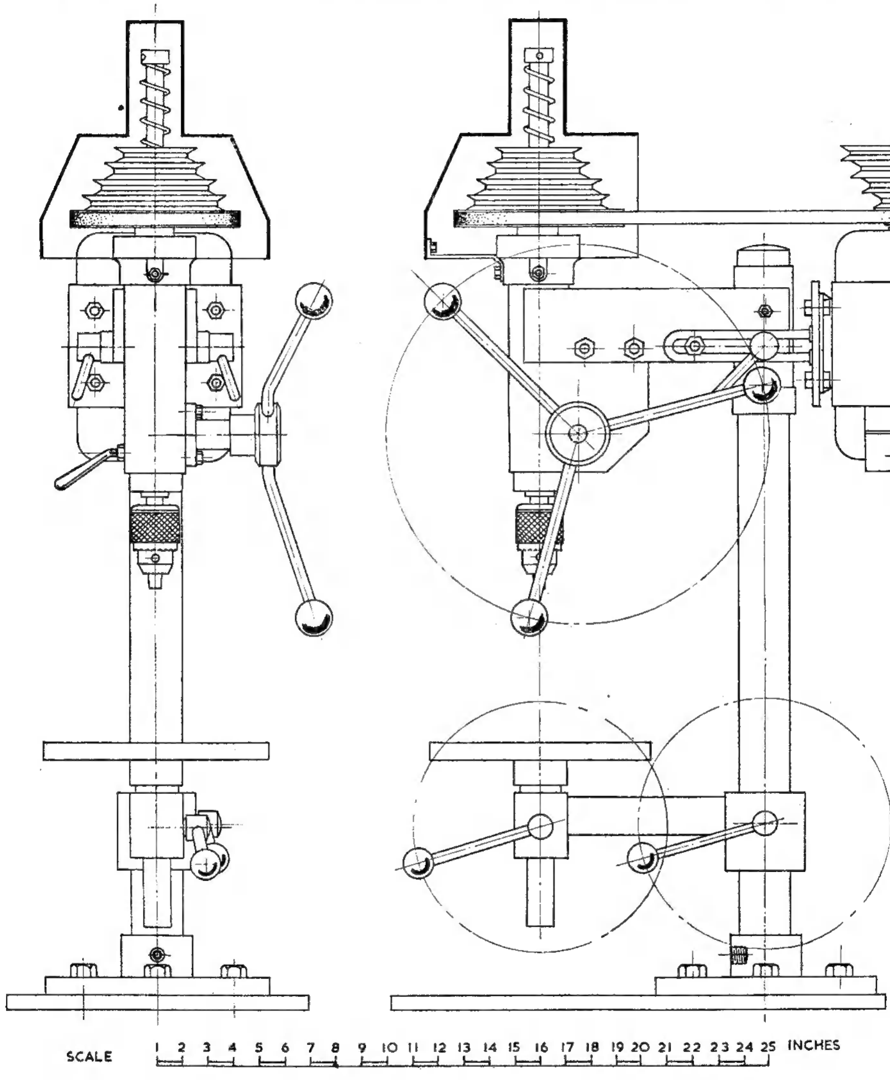


Fig. 1. *General arrangement of the* 0-$\frac{1}{2}$ *in. drilling machine*

and the first operation was to bore the $\frac{7}{8}$ in. hole right through the centre. The outside diameter was then turned to make a nice sliding fit in the head or spindle tube. Both ends were then bored to take a ball race, type BRE $\frac{3}{4}$ in.—$1\frac{5}{8}$ in. o.d., $\frac{3}{4}$ in. bore and $\frac{5}{16}$ in. wide, and although these appear rather light they have given several years of good service. The quill was next milled by a friend to take a piece of rack gearing

After the quill had been completed, the pinion and feed-handle were then attended to. The feed pinion runs in a brass bearing which was turned from a $2\frac{1}{2}$ in. diameter brass bush and is $\frac{5}{8}$ in. bore and $1\frac{3}{4}$ in. long. It will be seen from the drawing that this bush is turned down from $2\frac{1}{2}$ in. diameter to leave a flange of $\frac{1}{2}$ in. thickness. Through this flange are three $\frac{1}{4}$ in. Whit. bolts to secure it to a piece of $2\frac{3}{4}$ in. $\times$ $\frac{1}{2}$ in. bar which

in turn is secured to the 3 in. × $\frac{1}{2}$ in. head bars by means of $\frac{3}{8}$-in. bolts through the holes previously drilled to receive same. I did not fix this in position [illegible] yet, not until I had machined the pinion shaft to fit the bush, and then, I found that, naturally, I had to cut [illegible] piece out of the spindle tube for the pinion and rack to mesh!

After determining the best position for the

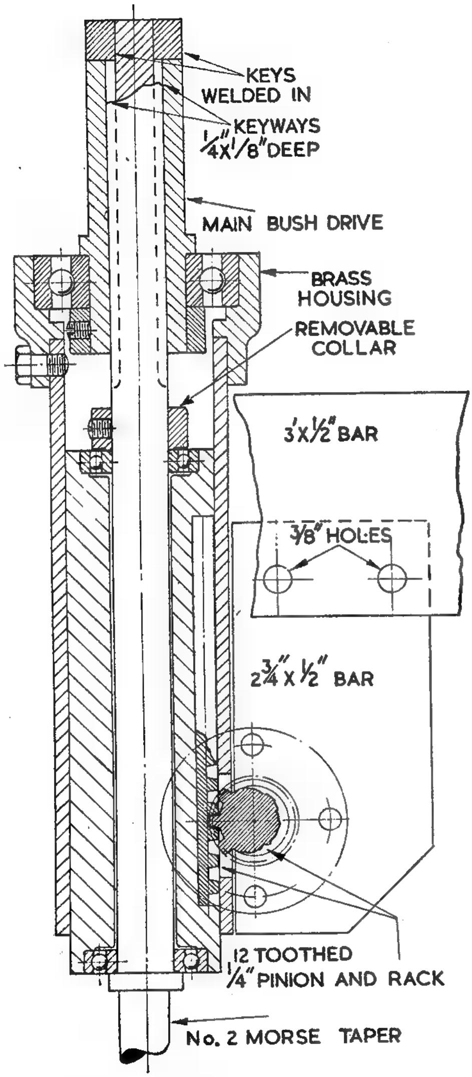


Fig. 2. Section of spindle drive head

pinion and bearing assembly, I marked off the two holes in the $2\frac{3}{4}$-in. × $\frac{1}{2}$-in. bar and after drilling these holes $\frac{3}{8}$ in., I bolted the whole to the head unit.

The main spindle was next cut from 1 in. diameter mild-steel and measures 19 in. in length. One end of the spindle was turned No. 2 Morse taper to fit the 0 to $\frac{1}{2}$ in. chuck, while the remainder was turned down to $\frac{3}{4}$ in. to fit the bearings in the quill, except for [illegible] collar $\frac{1}{4}$ in. thick which was to take the thrust and comes between the chuck and the first quill bearing.

A removable collar of $\frac{3}{4}$ in. bore was turned and fitted above the top quill bearing so that the main spindle would be securely locked between the two quill bearings, but free to revolve.

The spindle was then milled for the two keyways opposite each other for the full distance from the top collar to end of spindle, and the keyways are $\frac{1}{4}$ in. wide and $\frac{1}{8}$ in. deep. The top collar is secured to the spindle by means of a $\frac{5}{16}$-in. Allen screw.

The main drive bush was next machined from a piece of $1\frac{1}{2}$ in. diameter mild-steel and is $4\frac{1}{2}$ in. long. This was bored and reamed $\frac{3}{4}$ in. to take the main spindle and then turned down to $1\frac{1}{4}$ in. diameter for $1\frac{5}{16}$ in. of its length. A $\frac{1}{4}$ in. wide collar was left and the remainder turned down to $1\frac{1}{4}$ in. to take the vee-belt pulley. Two slots were cut in the bore at the top or pulley end of this bush, to take two small keys, which were welded in position clear of the bore. After this, the main spindle, was made to slide up and down this steel bush, the small keys engaging in the two keyways, milled in the main spindle for this purpose. In the first machine I made, I used two $\frac{3}{8}$-in. studs in place of keys and after filing the ends to fit the keyways, I drilled the bush and tapped two $\frac{3}{8}$-in. holes, using taper tap only, thereby, ensuring that the two $\frac{3}{8}$-in. set pins were [illegible] very tight fit in these holes and would not revolve when working. The heads of the set pins were cut off and filed flush with the $1\frac{1}{4}$ in. diameter shaft or bush. Both these methods have proved very satisfactory in operation, but I think the latter is preferable, because of the larger contact surface of the keys.

Before the completed bush was fitted into the top bearing, [illegible] collar was made from 2 in. diameter shaft to prevent the bush from coming out of the top bearing when in position. After this was done and the bearing and whole assembly was fitted into the brass bush at the top of the spindle tube, it was now time to see about the vee-belt pulley.

There were on the market at that time, a number of five-step vee-belt pulleys of $\frac{1}{2}$ in. bore. As I could not obtain one of suitable bore to match this or of correct size, I made [illegible] pattern and had one cast in aluminium at the local foundry. I took the dimensions from [illegible] friend's machine which was fitted with a motor pulley the same size as my five-step $\frac{1}{2}$ in. bore one, so this saved me a good deal of trouble. The dimensions of the five-step motor pulley at the top of the vees are $1\frac{7}{8}$ in., $2\frac{3}{4}$ in., $3\frac{5}{8}$ in., $4\frac{3}{4}$ in., $5\frac{5}{8}$ in., and the spindle pulley dimensions at the top of the vees are $3\frac{1}{4}$ in., $4\frac{1}{4}$ in., 5 in., 5^{7} in., $6\frac{3}{4}$ in. The finished turned pulley was fitted to the $1\frac{1}{4}$ in. diameter bush by means of two $\frac{3}{8}$-in. Whit. Allen screws. Two countersunk holes were drilled in the bush for these two Allen screws to bite into, ensuring a good drive.

A new 1/3 h.p., 250 V a.c., single-phase motor was purchased and the $\frac{1}{2}$ in. bore vee-belt pulley opened out to $\frac{5}{8}$ in. to fit this motor. The motor [illegible] of the 1,450 r.p.m. type which, in keeping

with the pulley sizes, will be suitable for drilling holes up to $\frac{1}{2}$ in. satisfactorily. The motor plate was drilled and motor bolted to this and after fitting the motor pulley, the whole assembly was fixed to the head temporarily to ascertain the position of holes in the head plates for motor brackets and allow for adjustment of belt tension. These holes, four in number, were drilled 13/32 in. for $\frac{1}{2}$-in. Whit. tapping and the whole motor assembly bolted to the head by means of these.

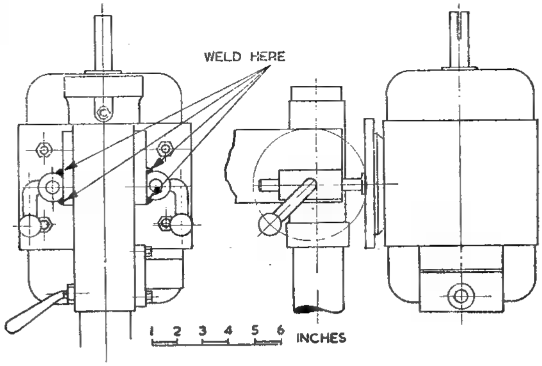


Fig. 3. Alternative type of adjustable motor plate

There were still several jobs to do before giving the head a trial run. The first was to turn a small handle to fit a $\frac{3}{8}$-in. Whit. tapped hole in the bottom of the spindle tube. This, you may remember, engages at the end in the $\frac{5}{16}$-in. × $\frac{3}{16}$-in. slot milled straight through the quill. This stud or handle is fitted with a locknut so that, when the machine is at work, the handle can be locked in a given position so it will not allow the quill to turn and yet allow it to move freely up and down.

The second job was the feed handle, the boss of this being turned from $2\frac{1}{2}$ in. diameter mild-steel and is 2 in. long. The bore is $\frac{5}{8}$ in. to fit the pinion shaft and the whole handle when completed is secured to the shaft by a $\frac{3}{8}$ in. Whit. Allen screw. Three 15/32-in. holes were drilled to take the three handles in the boss. The three handles were cut from $\frac{1}{2}$ in. diameter mild-steel and are turned down at the ends to drive tightly into the 15/32-in. holes in the boss. The boss was clamped firmly in the vice and the handles bent outwards by means of a piece of pipe fitted over each handle in turn, taking care to bend each one equally. There are now available some round plastic knobs and if these are to be fitted, the ends of the $\frac{1}{2}$ in. diameter handles require turning down and screwing to suit the holes tapped in the knobs.

Instead of bending the rods or handles as described, the boss may be drilled with the three holes at the correct angle so that no bending is necessary. As the drill head was rapidly nearing completion I had to devise some method of a spring return for the drill spindle. This was a very simple device and consists of a suitable spring fitted over the main spindle and resting on top of the vee-belt pulley, or perhaps I should say more correctly the main drive bush. A collar of $\frac{3}{4}$ in. bore is fitted to the top of the drill spindle and secured by a $\frac{1}{4}$-in. Whit. Allen screw. It will be seen that as the drill spindle is fed downward, the spring will be compressed and will return the spindle to the normal position automatically when the feed handle is released.

A collar of $2\frac{1}{2}$ in. diameter, 2 in. bore and $1\frac{1}{8}$ in. wide was fitted to the column under the main head and was secured by a $\frac{1}{2}$-in. Whit. set pin. This is really for safety in case the $\frac{3}{8}$-in. Whit. set pins securing the drill head to the column should become loose, thus allowing the drill head to rest on the collar and not slide down the column. I have found this very handy when wanting to move the drill head left or right, as the whole weight of the head can be revolved and clamped in any position in an arc.

A Trial Run

After coupling up the motor and securing an endless vee-belt of the correct length, the whole head unit was given a trial run and it behaved very well. A few minor adjustments were made and then the drill did its first job of work. This was to drill a $\frac{1}{4}$-in. hole through the 2 in. diameter by $2\frac{1}{2}$ in. long round mild-steel welded to the end of the table arm. The $\frac{1}{4}$-in. hole was used as a pilot and opened out to $\frac{3}{4}$ in. to take the table spindle. This arm was clamped to the column temporarily by means of a $\frac{3}{8}$-in. set pin and was taken out and a handle fitted with plastic knob made to replace same. Another similar handle was machined and a $\frac{1}{2}$-in. Whit. hole tapped in the side of the 2 in. diameter end of the table arm (just bored out to $\frac{3}{4}$ in.) to receive this. The use of the second handle is to clamp the table spindle when only short height adjustments are being made, when it is not necessary to move the table up or down the column.

The table was machined from a casting once more obtained from the local foundry and is some 9 in. in diameter. It has four slots cast in, rather like a lathe faceplate, these, of course, being used for clamping work to the table.

The table spindle was turned from 1 in. dia. mild-steel and is $7\frac{1}{2}$ in. long. The spindle is machined to $\frac{7}{8}$ in. dia. to drive into the centre hole bored in the table and after leaving a $\frac{3}{16}$-in. collar, the remainder turned down to $\frac{3}{4}$ in., this being a good but sliding fit in the hole in the table arm. The drill was by now nearly completed, except for a coat of paint and a belt guard made from sheet and secured to the head by means of the three bolts which also secure the bearing housing to the spindle tube.

The finished unit is strong, rigid and reliable and has done a good ideal of heavy drilling since completed. There are only two more refinements I should like to add and they are a depth stop, fitted to the base of the quill, and a push-button or similar switch built on to the head. I think the latter is necessary for the operator's own safety, as the switch of any such machine should be close at hand so that it can be switched off quickly if necessary.

The S.E. Association Regatta

Mr. B. Whiting (Orpington) with the steam-driven cruiser " Eileen "

HEAVY rain in the early part of the day undoubtedly reduced the attendance at this regatta, held recently at Brockwell Park, S. London. Most of the well-known enthusiasts were, however, undeterred by the bad weather and helped to make the day a success.

Due to local noise regulations, the speed craft were run off during the morning and the straight runners after lunch, so that the programme was commenced with Class " C " and " C " Restricted boats racing over five laps. No very spectacular performances were seen in this event, but J. Benson's *Moth* made a determined onslaught on the retrieving boat during one attempt ; luckily it did not collide head on, but just scraped the stern so that no serious damage was done. No " C " Class Restricted boat completed the course, but R. Phillips, with *Foz*, won the Class " C " prize with a speed of 37.8 m.p.h.

In the 500 yd. " B " Class race, the favourite, G. Lines, had bad luck when *Sparky II* capsized on both runs. This appeared to be due to disturbed water, as none of the speed boats looked very happy as regards stability. F. Jutton's flash-steamer, *Vesta II*, managed to get round at 48 m.p.h. to record the winning speed, but it was touch and go whether *Vesta II* would keep on the water for the full distance.

When the " heavyweights "—the Class " A " boats—came to perform, it appeared that their larger dimensions enabled them to ride the bumpy water better than some of the previous craft.

A. Cockman's *Ifit 7* recorded a second successive win in this five-lap race at a speed of 51.1 m.p.h. This flash-steamer is now recording over 50 m.p.h. at practically every meeting.

J. Innocent, with *Betty*, took second place, and B. Miles followed up with *Typhoon*. A new two-stroke engine installed in the hull of *Gordon 2* by E. Clark, had to be withdrawn due to mysterious explosions occurring in the fuel tank !

The last of the speed events was for Class " D " boats and F. Walton's *Jolt* was the winner at 28.4 m.p.h.

The nomination and steering events wound up the programme, and these events marked the first appearance of boats from the Welling Club. Members from this club took places in both of these events ; an exceedingly good performance for a first regatta.

Results

Class " D " Race. 500 yd.
1st. F. Walton (Kingsmere), *Jolt*, 28.4 m.p.h.
2nd. J. Pinchin (Blackheath), *Black Widow*, 26.9 m.p.h.
3rd. C. Hancox (Kingsmere), *KM* 3, 24.7 m.p.h.

Class " C " Race. 500 yd.
1st. R. Phillips (S. London), *Foz*, 37.8 m.p.h.
2nd. B. Miles (Kingsmere), *Dragonfly*, 37.6 m.p.h.

Class " B " Race. 500 yd.
1st. F. Jutton (Guildford), *Vesta II*, 48 m.p.h.
2nd. N. Hodges (Orpington), *Sparta*, 29 m.p.h.

Class " A " Race. 500 yd.
1st. A. Cockman (Victoria), *Ifit* 7, 51.1 m.p.h.
2nd. J. Innocent (Victoria), *Betty*, 44.4 m.p.h.
3rd. B. Miles (Kingsmere), *Typhoon*, 42.6 m.p.h.

Nomination Race
1st. F. Curtis (Kingsmere), *Korongo*, error 6 per cent.
2nd. Mr. Atkinson (Welling), error [illegible] per cent.
3rd. R. Duncan (Croydon), *Zoe*, error 9 per cent.

Steering Competition
1st. Mr. Clark (Welling), 10 pts.
2nd. Mr. Watts (S. London), [illegible] pts.
3rd. R. Shepherd (Enfield), 7 pts.

" Vesta II " (F. Jutton, Guildford) caught in one of her rare docile moments

---

For the Bookshelf

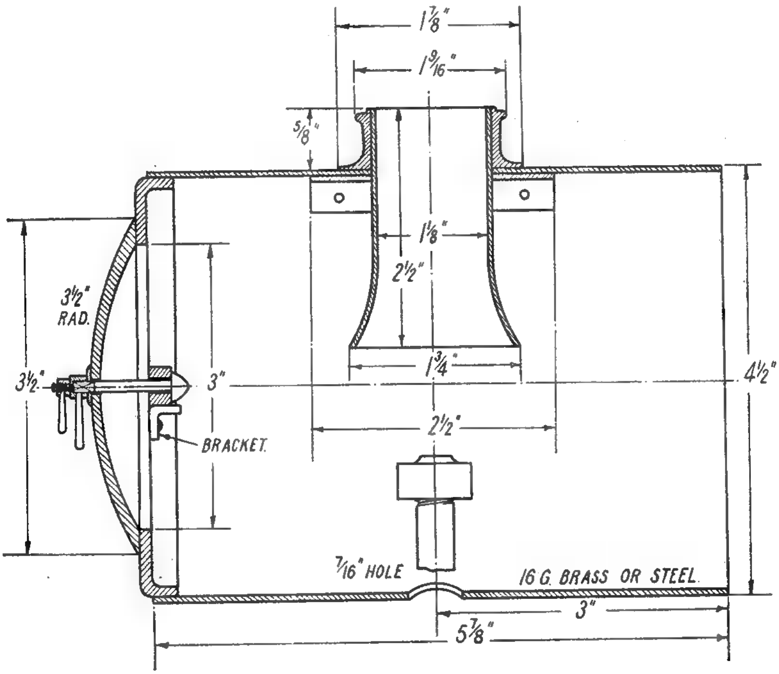
Hand Tools, by R. Harris. (G. Bell & Sons Ltd., York House, Portugal Street, London, W.C.2.) 5s. net.

The author has produced a handy little book for the beginner which, without pretentious complexity, achieves the useful purpose of establishing an adequate introduction to the handling of tools. The chapter on materials is indeed a worthy addition and will enable the tyro to gain a certain degree of knowledge of the substances upon which he is likely to operate.

"PAMELA" by "L.B.S.C."

A $3\frac{1}{2}$-in. Gauge Rebuild of a Southern Pacific

As the rest of the work on *Pamela's* boiler is carried out in the manner fully detailed for *Tich*, repetition should be unnecessary; and if I just draw attention to the points where the actual construction differs, nobody should encounter difficulty. Note when assembling the firebox and tubes in the shell, that the smokebox tubeplate is fitted with the flange *outward*. The projecting part of flange, forms the attachment for the smokebox. It won't be necessary to use a "holey" tray, for brazing the circumferential joint; just lay the boiler in the brazing-pan, do as much of the joint as you can get at, then turn the boiler over, to expose a bit more of the joint. About three "goes" should complete the circumference. The tubes, which should be expanded as per the *Tich* instructions, can be silver-soldered by up-ending the boiler, and blowing direct on them; a five-pint lamp should provide enough heat to melt best-grade silver-solder, or "Easyflo," without any need for packing around with coke. If you can get two blowlamps on the job of silver-soldering the top flanges of the crown stays, one blowing inside and the other on the outside of the wrapper, this job should be a "piece of cake"—hot from the oven!



Section of smokebox

The backhead is shown in the accompanying drawing, which also gives the size of the former plate; our approved advertisers may be able to supply cast formers. Knock up the backhead from 10-gauge copper; nick the flanges at $1\frac{5}{8}$ in. from the top, and bend as shown in the longitudinal section of complete boiler. Locate firehole ring, cut the hole, and fit the backhead *à la Tich*. Fit remaining sections of foundation-ring in same way, using $\frac{5}{16}$-in. square copper rod, and 3/32-in. rivets. Don't forget to plug any interstices with splinters of copper; bevel the bits of ring, to form a channel for the brazing material. Lastly, fit the dome and safety-valve bushes.

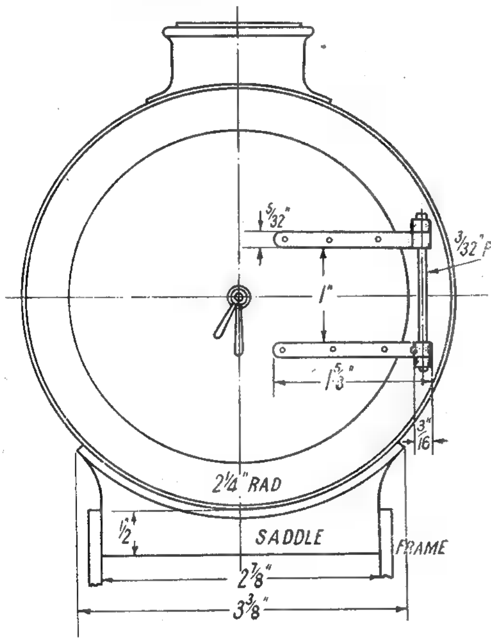
Situation Vacant!

It frankly needs a dickens of a lot of "therms" to make a good and neat job of the final brazing operation; and if you can enlist the services of a "mate" armed with another blowlamp or blowpipe, even if only a small one, it will make the job considerably easier. Even a kiddy who could hold a lamp steady, and wasn't afraid of noise and heat, would do fine, and would probably be tickled to death at being able to lend a hand in the building of the boiler. Anyway, proceed with the

setting-up, coke packing, preliminary heating of the whole lot, and so on, as described for *Tich*; and when you start to concentrate on the bottom corner of the foundation ring, to start the brazing material running, get the mate to follow the movement of the flame of your lamp, with the one he is operating, so that both flames converge from different angles, on to the same spot. If that doesn't make the brazing strip run with alacrity, nothing on this earth will! Work right around, then up-end the boiler and go around the backhead, finally doing the bushes with silver-solder.

A Question of £ s. d.

If you only have the one blowlamp, or air-gas blowpipe, maybe it would be advisable to use a coarse-grade silver-solder (Johnson Matthey's B6 alloy, or ordinary No. 3 grade) for the foundation-ring and backhead; and "Easyflo" or No. [redacted] grade, the best kind made, for the bushes. This is just as strong as ordinary spelter, or easy-



Smokebox front and saddle

running brazing-strip; the drawback is the expense. Incidentally, I recollect our good friend Bro. Hyphen mentioning that he proposed specifying silver-solder for the boilers of his twins. Anybody who is going to make one, had better start saving up right now, the way prices are continually on the up-and-up, and it needs [redacted] tidy bit of silver-solder to do all the joints of [redacted] 5-in. gauge boiler, even for [redacted] small type of locomotive!

A Tip [redacted] Tips

Lucky owners of oxy-coal, or better still, oxy-acetylene blowpipes, shouldn't have the slightest trouble. A good wheeze, which I always make use of in my own work, is to use a far larger tip in the blowpipe, than the makers' specify, and work with [redacted] lower gas pressure. For the backhead and foundation-ring of [redacted] boiler like *Pamela's*, I should use the biggest tip in my set, 1,000-litre, and adjust the pressure regulators to give a big flame with not too much hiss, more like the flame of the oxy-coal pipe. This flame covers enough area, to allow the Sifbronze rod to melt and flow very quickly, and at the same time amalgamate thoroughly with the copper, not only filling up the grooves, but penetrating right through the joint. Some folk say they cannot get Sifbronze to run clean through a joint, but it always seems to behave itself with your humble servant. Of course, it won't run through if the full depth of the foundation-ring, flanges, or whatever it is you are doing, is not at the proper heat all through; and that is just where the big flame scores. If the flame is too small, you may get enough heat at the surface of the joint, to melt the Sifbronze and get a good surface amalgamation; but it isn't as strong as full depth penetration. Ordinary brazing-strip, or some of the patent brazing materials sold in rods like welding bronzes, can be used with an oxy-coal blowpipe; but anything hotter, simply volatilises the zinc in the composition, and you get a faulty joint. You can always tell when the zinc is burning, it gives a bluish flame and clouds of white smoke, which isn't too good to get in your lungs.

Other Times, Other Methods

Some of the old craftsmen coppersmiths, who plied their trade before oxy-coal and oxy-acetylene equipment were ever dreamed of, would have been able to braze up the whole of *Pamela's* boiler in [redacted] plain forge, without any blowlamp at all, and using only a big coke fire, bellows-blown through a tuyere—"under a spreading chestnut tree" sort of outfit. I wouldn't mind betting that old Tommy Goodhand could do one that way, if he liked, just using brass wire and borax; and it would be a sight worth seeing, to watch the final operation, with the whole lot glowing jolly nearly hot enough to see the tubes through the barrel! It would stand about 2,000 lb. pressure, and never leak in a thousand years. However, Bro. Thomas moved with the times; when I last visited his works at Gillingham, before Hitler went loopy, he was cutting out the firehole in a steel vertical boiler shell taller than himself, with an oxygen cutting blowpipe. He is our oldest advertiser; was making boilers when the first number of this journal appeared, and is still at it, [redacted] wonderful record.

When the final brazing job is finished, be very careful indeed how you put the boiler in the pickle. My favourite trick is to use the garden rake to lift the boiler, but you need [redacted] mighty strong pair of wrists for that, owing to the weight of the boiler, and the leverage. If you have been able to enlist the aid of [redacted] mate on the blowlamp job, about the best way to baptise the boiler would be to put [redacted] couple of wire loops around it, poke [redacted] long stick through, or [redacted] piece of gas pipe or something similar, and lift at both ends, both standing well clear of the pickle bath. There will be [redacted] miniature volcanic eruption when the pickle runs inside, for the first few seconds, so watch your step! Anyway, leave the job to soak for

twenty or thirty minutes, then fish it out, drain all the acid from the inside, and well wash inside and out in running water. Clean the outside as before, then test for pinholes as per *Tich's* instructions.

Staying

The four longitudinal stays are made from $\frac{3}{16}$-in. copper rod, screwed at both ends and furnished with blind nipples screwed externally $\frac{5}{16}$ in. × 40 and tapped $\frac{3}{16}$ in. × 40. The seven cross-stays in the Belpaire wrapper are similar, but shorter. Note, there is no hollow stay; we are using a separate blower pipe. All stay rods should reach from the outside of the plate at one end, to the outside of the other plate at the other end. Screw them $\frac{3}{16}$ in. × 40 in the lathe, using a die in the tailstock holder, and give them a good dose of cutting oil, to ensure clean threads. The nipples are made from $\frac{3}{8}$ in. hexagon brass rod; any kind will do. Chuck in three-jaw, face the end, centre and drill down $\frac{3}{8}$ in. depth with 5/32-in. or No. 22 drill; tap $\frac{3}{16}$ in. × 40. Turn down $\frac{5}{16}$ in. of the outside to $\frac{5}{16}$ in. diameter, and screw $\frac{5}{16}$ in. × 40. Both threads must be the same pitch, naturally. Part off to leave a head a full $\frac{1}{8}$ in. thick; reverse in chuck, and chamfer the corners of the hexagon.

To fit the stays, insert the end of a rod about three threads, into a nipple, then poke the rod through the hole in one end, or side, of the boiler, and guide it to the corresponding hole in the other side or end. I usually put a long piece of thin tube clean through both holes, put the end of the stay in it, and withdraw until the nipple touches the boiler. The nipple is then screwed right home, and the bit of tube completely withdrawn, leaving the screwed end of the stay just standing out of the hole in the opposite plate. The other nipple is then started on this protruding end, and screwed right home, locking the stay rod securely between the two nipples. You can either anoint the nipples with plumbers' jointing, or sweat them over when doing the firebox stays; just as you fancy.

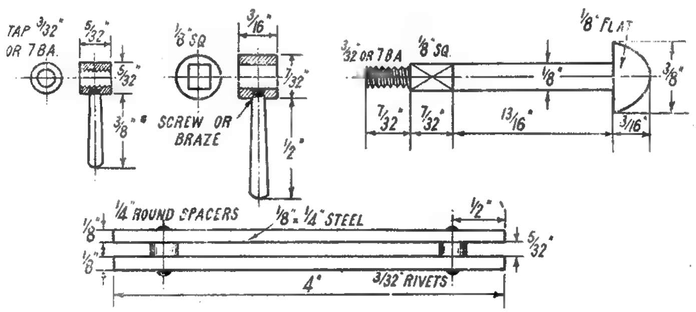
Patience is a Virtue

I have shown "real practice" firebox staying; and although the stays are numerous, they are easy to enough put in. The chief requisite is plenty of patience. I can do the job mechanically," with my thoughts far away (learned that trick off the munition girls on repetition work) but I shouldn't advise any beginner or inexperienced coppersmith to follow suit! However, all you have to do, is to mark the position of the stays according to the drawing—a full-sized blueprint is a great help here—centre-pop the places without making outsize dents in the copper, drill through both plates with No. 40 drill, and tap with a $\frac{1}{8}$-in. or 5-B.A. staybolt tap. This is a "second" tap with a long pilot pin which is an easy fit in the No. 40 holes, and ensures that the tap goes truly through each hole, the threads being "continuous," so that the staybolt will screw through both plates. Both Reeves and Kennion Bros. supply them. Use plenty of cutting oil when drilling and tapping.

How to Make and Fit the Staybolts

My usual method is to cut a few lengths of $\frac{1}{8}$-in. copper rod, about 4 in. or so, screw both ends of each in the lathe, then screw one end into one of the tapped holes until it reaches the end of the thread. The rod is then snipped off about $\frac{1}{8}$ in. from the plate, and a brass locknut screwed on the bit projecting into the firebox. Any rod standing out beyond the nut, is snipped off too. When all the rods have been beheaded and curtailed, the whole lot are re-screwed, and the ceremony repeated until all the staybolts are in. In the present instance, the end stays need $\frac{3}{8}$ in. of thread, and the side stays $\frac{5}{8}$ in. As you can get your hand in the firebox, an ordinary spanner can be used to tighten the nuts. Warning: don't forget that in this boiler, owing to the shape of the firebox wrapper, two additional side stays (a bit larger, $\frac{3}{16}$ in. × 40) are needed to support the wrapper ahead of the firebox; and the nuts for these are just inside the combustion chamber. The position of these special stays, is clearly indicated in the longitudinal section of the boiler.

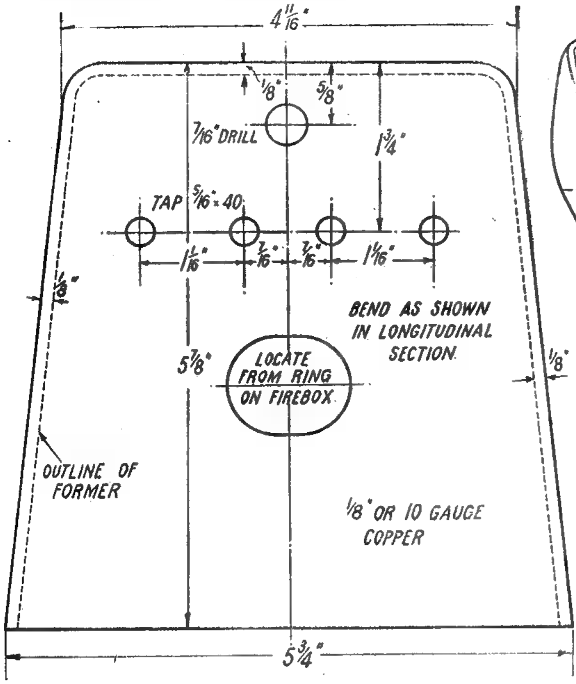
When the whole lot are in, put a piece of iron bar in the vice, leaving about 4 in. or so projecting from one side of the jaws. Put the firebox over this, rest each stay nut on the bar, and hammer down the piece of stay on the outside of the boiler, to form a rivet head. Take care to hit the stay and not the boiler. This process will also burr over the bits of stay projecting through the nuts; but give them all a final tighten-up with a small spanner.



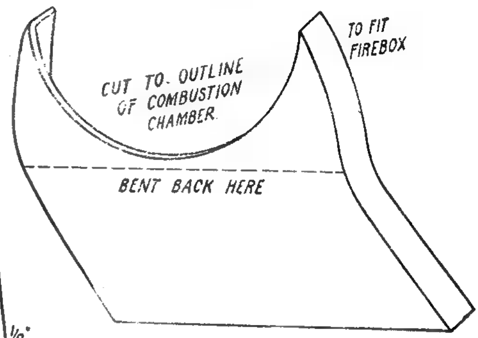
Details of dart, handles and crossbar

Sweating the Heads and Nuts

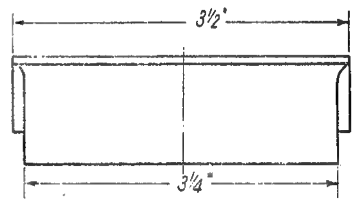
If the threads in the holes, and on the staybolts, [redacted] clean and of the right size—the stays should fit tightly—they should be steamtight without further attention ; but as soft copper frequently tears when being screwed and tapped, it is advisable to sweat over the heads and nuts. The job is easy. Brush some Baker's fluid or other liquid soldering-flux all over the heads and nuts ; don't use [redacted] paste flux on any account. Heat the whole boiler to the melting point of solder, and apply a little among the cluster of stayheads ; then, keeping up the heat, spread the melted solder over all the heads and nuts, with a wire brush. You can make that for yourself, by driving a small bunch of thin iron wires into the end of [redacted] bit of ¼ in. copper tube, and flattening the end. See that all heads and nuts are well treated, and be sure to cover the whole of the inside firebox, so that the copper plates are tinned all over. There are two advantages in doing this ; No. 1 is that if by any chance there *should* be [redacted] pinhole in one of the seams or joints, or a rivet-head which might develop [redacted] whimper or shed a tear, you stop it before it starts (says Pat). No 2 is that the tinned surface being more "greasy" than bare copper, soot and hard carbon doesn't tend to stick to it, and the firebox plates keep cleaner and are thereby more efficient in transferring heat to the water. Keep dipping the wire brush in the liquid flux all the time you are on the job. If the heads of the screwed nipples have not been treated with plumbers' jointing, wet them with the flux and apply [redacted] bead of solder alongside each. A few seconds' application of the blowlamp flame will cause the bead to melt, and flash around the head in [redacted] neat fillet. Alternatively, apply [redacted] taste of solder to the side of each, with [redacted] soldering-iron, directing the flame on the head at same time. The result will be the same. When through, thoroughly wash out the boiler, and clean all traces of flux from the outside. Any remaining, will turn the copper green, and leave a poisonous deposit—what my old granny used to call "verdygrease."



Boiler backhead



Sketch of front plate of firebox



Smokebox saddle

The boiler can now be tested to 160 lb. by water pressure. I have described many times how to do this, by aid of an ordinary tender pump, and [redacted] pressure gauge as used on full-sized engines [redacted] so there is no need to repeat instructions here. All being well, I shall deal with it fully, for beginners' benefit, in the story of *Tich*. Note—there is no need to strain the boiler unduly, by going above 160 lb. We are not making a destruction test, and the pressure stated is ample for the working pressure of 80 lb. which will do all you are ever likely to need. The boiler is strong enough for [redacted] much higher pressure, [redacted] I always try to err on the safe side.

Smokebox

Before putting on the boiler fittings and mountings, the smokebox may as well be made ; then the whole lot will be ready for erection together. The spam-can "thimble" has been replaced by [redacted] smokebox and chimney, similar to that designed for the full-sized "Austere Adas" by Mr. R. A Riddles, and is [redacted] plain straightforward job needing no detailed descrip-

tion. The illustrations explain themselves. The barrel of the smokebox is a piece of 4½-in. × 16-gauge brass tube (steel may be used if desired, but brass is less liable to corrosion) squared off in the lathe to a length of 5⅞ in. The smokebox front and door may be made from castings—our approved advertisers will do the needful—or may be knocked up from ⅛-in. brass blanks. In the latter case you'll have to make separate hinges from 5/32-in. × 18-gauge strip metal; steel would do, but nickel-bronze (German silver) would look better when polished up on a black door, reminiscent of the days when the now extinct race of cleaner boys flourished.

The crossbar is made from two 4-in. lengths of ⅛-in. × ¼-in. steel, riveted together with 5/32-in. spacers between, as shown, and is supported by two little brackets bent up from 16-gauge steel, and screwed or riveted to the inside of the smokebox front ring, each side of the door opening. The dart is made from a piece of ⅜-in. × ⅛-in. flat steel, or alternatively from ⅛-in. round steel, with a flat head brazed on. The square hole in the key, can either be drilled ⅛ in., and then filed out with a watchmakers' square file to fit the square on the dart, or else squared by driving a punch through after drilling, the punch being made from ⅛-in. square silver-steel. The assembly of the whole bag of tricks is clearly shown in the section of the complete smokebox. If any inexperienced builder of *Pamela* needs further information he will find same in coming notes on *Tich*, which will be more fully detailed for beginners' benefit; but there is nothing complicated about the oddments described above, and as each piece is shown separately, nobody should have any trouble in making them.

Chimney and Liner

The chimney liner—some full-size enginemen call it a "petticoat pipe," and our cousins over the pond call it a "lift pipe"—may be turned from a casting, or made from a piece of copper or brass tube approximately 1⅛ in. bore. Doesn't matter if it is 1/32 in. smaller, but it shouldn't be any bigger, or the blast won't fill the chimney, and the fire won't "draw." It needs a good draught for the big grate. Square off the bit of tube to a length of 2½ in. and bell out the bottom to 1⅝ in. diameter by spinning, drifting (same as a plumber bells out a lead pipe) or simply laying the tube on the edge of a block of lead, and judiciously applying the ball end of your hammer-head. The tube should be well annealed before treatment. Hit all around the inside of the end, and you will soon get a bell-mouth.

The tube is attached to the smokebox by a square flange, secured by four 3/32-in. countersunk brass screws, nutted inside. Cut out a piece of 18- or 20-gauge brass or copper, 2½ in. square; drill a hole in it to suit the liner, then bend it to the curve of the inside of the smokebox. Put the tube through, and silver-solder it *à la* Cohen, Macpherson & Co. If you get too much silver-solder on the joint, the flange won't bed against the smokebox shell, ye ken, and the surplus silver-solder will have to be filed off, a shocking vaste of goot material, vot you tink, eh? Put a taste of plumbers' jointing around it, and erect as shown.

The chimney is turned up from a casting. Chuck in three-jaw, and bore to a tight push fit on the liner; then mount it on a mandrel (bit of round wood will do) and turn the outside as shown. It is not fixed in any way, simply pushed over the projecting end of the liner. The easiest way of getting the base to sit nicely on the curve of the smokebox, is simply to wrap a piece of emery-cloth or other abrasive around the smokebox shell, and rub the curved base of the casting on it. You won't find that method of "machining" described in any text-book, and it would cause Inspector Meticulous to make a frantic search for the nearest source of stimulant—but I can assure you that it is mighty effective!

Smokebox Saddle

The saddle is also a casting; and all the machining it should need, will be cleaning up with a file, the curved seating for the smokebox being given a dose of the medicine prescribed for the base of the chimney, as set out immediately above. It should be a fairly tight fit between the frames. Don't bother about attaching it to either frames or smokebox yet, as the whole lot will be erected together, the operation being dealt with in due course. Just see that the smokebox fits over the projecting flange of the tubeplate all right, and comes flush with the boiler barrel. If it is too loose, tap the flange outward a little, all around, with the ball end of the hammer head. If too tight, reverse process—and the hammer head!—and tap inwards. It should be a fairly tight fit.

As some good folk are still hazy about the exact shape of the front plate of the firebox, imagining that it extends almost to the roof, thus forming a baffle between firebox and combustion chamber, I am appending a little perspective sketch of the plate. This clearly shows that although the flanges at each side extend almost to the roof, the centre part is cut away to the contour of the combustion chamber, leaving it perfectly open and unobstructed in any way whatever.

Cemented Tungsten Carbide-Tipped Tools

We have recently received from Messrs. Protolite Ltd. an interesting catalogue and technical bulletins describing their range of cemented tungsten carbide-tipped tools.

The catalogue is well illustrated, giving tool clearances and angles together with other useful information regarding the grades of "Prolite" hard metal. The technical bulletins outline some of the many and varied uses to which Prolite-tipped tools have been successfully put, and are based on information supplied by satisfied customers.

There must be many readers who would find use for these tools in their home workshops, and the manufacturers, Messrs. Protolite Ltd., Central House, Upper Woburn Place, London, W.C.1, will be pleased to furnish catalogues and other technical data, upon request. The principal qualities of Prolite are, of course, its durability and wide range of application.

A Simple Direct Current Circuit Breaker

by F. W. Roberts

MOST model makers with electrically driven models or railways have found a fuse essential to protect their batteries or power packs ; but fuses are tedious to replace, and the need to do so is frequent with some devices (particularly model trains). This simple circuit breaker is better than a fuse, is instantly reset (" repaired ") and can be remotely controlled. All that is needed is an *ex*-government relay and about 20 ft. of covered copper wire. It is not necessary to touch the device to reset it and so it can be built inside the power pack or battery box.

The relay is simply a sensitive but robust unit which operates some contacts when its central core is magnetised. Usually the coil of wire provided for this purpose consumes very little current and has a fairly high resistance. If we wind a second coil on top of the first one and provide thicker wire—but fewer turns—the relay will work at a higher current and will not impede its flow because it will have a much smaller resistance. This is what we do, arranging the new coil to just work the relay at the maximum permitted current from the batteries, i.e. the current at which the fuse would have melted.

Select a relay from the usual *ex*-government stores, such that its existing coil will work on the normal voltage of your battery or power pack. Also, see that it has at least two pairs of contacts ; one must be closed and the other open when the relay is at rest. More contacts may be useful but are not essential. All relays that I have seen have had a clearance space around the coil and this is necessary to allow room for the new coil which has to be wound on top of the old one. Unscrew the circular nut holding the relay core and coil and also the screw retaining the armature (see Fig. 1) ; remove the armature carefully and then withdraw the core and coil. Bore a small hole in the end flange to anchor the first turn of the winding, select your wire (see later for method of selection) and wind on the correct number of turns carefully and evenly. Finish off with two layers of plain cotton tape and brush in shellac dissolved in methylated spirit or a good electrical varnish and then carefully reassemble the relay. All that remains is to connect up as in Fig. 2.

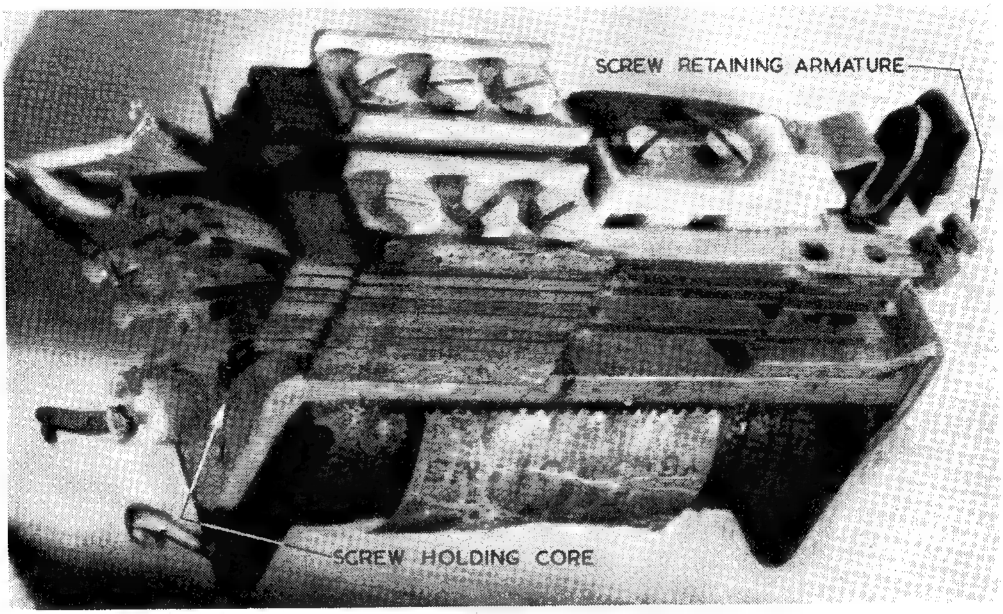


Fig. 1

Connections are simple and obvious ; the positive lead from your power pack goes through the switch which you will already have, then through the pair of contacts which are normally closed, then through the new coil and finally off to the model or the train. One side of the old coil is connected to the negative side of the battery, the other to the normally open pair of contacts ; from these a lead is taken to the switch mentioned above. As a result, until the relay operates all the current can flow freely through the new coil and none can pass through the old coil. If a

short circuit happens or the load grows too big, the current in the new coil will now attract the armature and so will open one pair of contacts; this will isolate the load and protect the power pack or battery. At the same time the other pair of contacts becomes closed; this completes the connection for the old coil which keeps the relay closed, the load isolated and the circuits safe. When the switch is opened the relay will stop working, i.e. will re-set it to normal and if the fault has been removed the model is at once ready for use again.

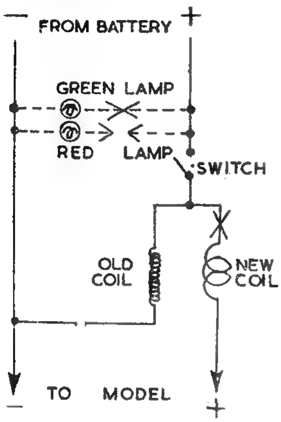


Fig. 2. Schematic circuit

Note.—If relay will not stay closed on overload but chatters in and out, reverse the connections at the terminals of the old coil; the new and old coils were opposing instead of aiding each other.

Selection of Wire for Second Coil

Most relays of the *ex*-government telephone type appear to need about 80 ampere-turns to operate them. This means that when the current multiplied by the turns reaches 80, the relay will operate. Thus, if it is to limit the current ½ ampere 160 turns are needed; for 1 ampere, 80 turns must be supplied; for two amperes 40 turns and so on. The size of wire must be bigger for the bigger currents. Suggested wire sizes are given in Table 1. The exact number of turns may need adjustment as some relays are more sensitive than others. The wire must be best high conductivity copper wire; enamel insulated is good, but enamel with single silk covering is better. Double cotton covering is good but may take up too much space.

TABLE I

Amperes	Suggested wire gauge	Equivalent diameter, inches	Approximate number of turns
½	23	0.024	160
¾	22	0.028	107
1	21	0.032	80
1½	19	0.040	53
2	18	0.048	40
2½	17	0.056	32
3	17	0.056	27

One gauge higher or lower will not make much difference.

An added refinement is a pair of indicator lamps, one green and one red to indicate whether the circuit is healthy or not. To do this, two more pairs of contacts are needed (making four pairs in all), one open and the other normally closed. Wire the green lamp across your battery through the closed contacts, and the red one across the supply through the open contacts. So long as the relay is at rest, the green lamp is alight; when it closes to isolate an overload or short circuit, the red lamp will come on and remain alight until the relay has been reset by switching off.

My own miniature circuit breaker was an *ex*-government relay type Y6.H-101 1 MS; its original coil was 250 ohms resistance and worked well on 10-12 volts d.c. I added 80 turns of wire (actually two lots of No. 23 gauge —0.024 in. diameter—not having No. 21 gauge; the two lots were joined electrically in parallel). This pulls in at 1 ampere and has a resistance of only 0.17 ohm, so its effect on the speed of the electric train it protects is negligible.

A Cleansing Preparation

We recently received a sample of an antiseptic hand cleansing preparation known as "Swarfega."

A green, semi-transparent liquid, "Swarfega" contains no abrasive; it is, however, an exceedingly reliable cleanser and will remove grease, dirt, stains and paint marks quickly and without scrubbing. Motorists may use it by simply applying to the hands and removing with a clean rag. It is also useful for cleaning paintwork, scrubbing floors and cleaning greasy overalls.

All tests carried out in the "M.E." workshop have proved completely satisfactory, and we have no hesitation in recommending it to our readers. It is obtainable in tins from ironmongers, or direct from the manufacturers, D.E.B. Chemical Proprietaries Ltd., Spencer Road, Belper.

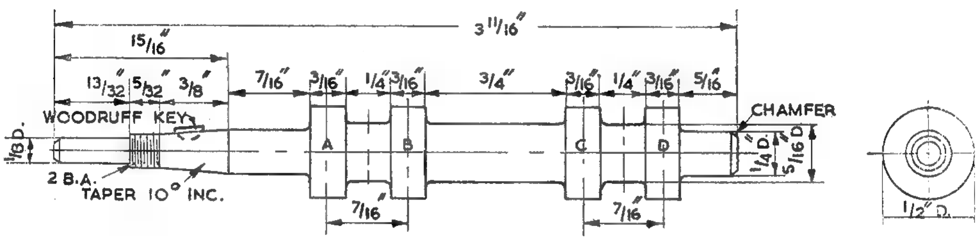
PETROL ENGINE TOPICS

*A 10 c.c. Twin Four-Stroke

by Edgar T. Westbury

IT will be noted that no provision has been made for keying the flywheel to the shaft, but as I have explained several times in connection with previous engines, this should not be necessary and is not, in my opinion, desirable. However, it is a purely optional feature, and if constructors prefer to fit a key, the type I recommend is the Woodruff or "half-moon" key, which is sunk deeply into the shaft and therefore provides maximum strength and security. Above all things, a key must be perfectly fitted to be of any use at all, and it must never be regarded as a substitute for a well-fitting taper. On no account resort to grub-screws of any kind to hold or key a flywheel; it should not be necessary to mention this, but I have seen many examples of this method of fitting, and the trouble it can cause. The much overworked Allen screw is sometimes used, with or without a locating dimple in the shaft; in either case, however, it is liable to tear the surface of the latter, and may cause seizure, and render removal of the flywheel difficult or impossible, if any relative movement takes place. With a good friction fit, however, slight shifting of the flywheel under excess torque does no harm, and may prevent damage to other parts of the engine in emergency, while attention is immediately called to any loosening of the flywheel, through slackening of the shaft nut. Perhaps I should apologise to readers for stressing this matter so often, but, I assure them that it is called for in view of the continued perpetration of ancient errors and fallacies among new constructors.

At this stage in construction, the shaft can be temporarily fitted to its bearings, and the two connecting-rods also fitted to ensure that they run freely and smoothly. In dealing with the machining of the split centre bearing, I omitted to mention that the two halves must afterwards be separated by heating to melt the solder, but this will be obvious to constructors; the joint faces should be wiped clean while hot, and if the machining has been correctly carried out, very little in the way of fitting should be necessary. Care should, however, be taken to see that the two halves of the bearing butt together hard when the cap is secured, and it may be found desirable to ease the face of the latter slightly to ensure this; but avoid taking more off than is necessary.



CAMSHAFT BLANK 1 OFF. M.S.

On no account should split bearings be adjusted by the nuts; if initial fitting is too tight they should either be scraped or reamed out, or shims fitted between the halves, so that the fit is correct when the cap is fully tightened. It may be found desirable to finish the main bearings by assembling all three and passing a $\frac{3}{8}$-in. reamer right through them. The split big-end bearings should also be fitted so that they work freely when the set screws are tightened. Initial fitting of bearings is more important on i.c. engines than some other types, as they will not work efficiently with sloppy bearings, yet they must be quite free running and have the minimum friction, without needing a long period of bedding down.

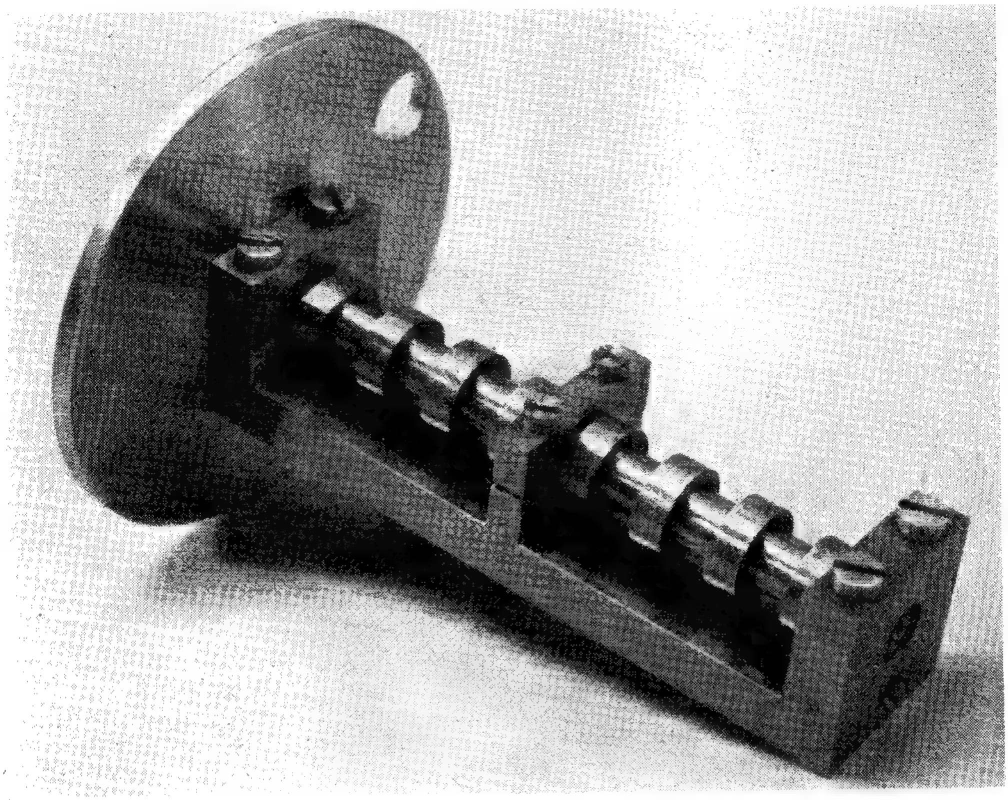
Camshaft

As in most previous four-stroke engines of my design, the cams are formed integral with their shaft, and though some constructors may think this a difficult operation, it is, in fact, much easier than making them separately and fixing each to the shaft in its exact location to produce correct timing. The shaft, with the cam blanks, is first machined between centres to the dimensions shown, and may either have the journal surfaces finished outright, including the taper for the timing gear, or they may be roughed down at first, and finished after the cams have been formed.

* *Continued from page 498, "M.E.," September 28, 1950.*

The cam contours are shown drawn to an enlarged scale, and the method recommended for forming them is identical to that used for the "Seal" engine. This consists of forming the flanks and the base circle by eccentric turning methods, and hand-filing the nose radius which is not of critical importance. The individual cams are indexed by means of ■ simple division plate attached temporarily to the shaft, which in not opposed to it as in common practice, the reason, of course, being that an idler gear is interposed between the crank and camshaft.

I am fully aware that many readers may lack confidence in their ability to produce an integral camshaft of this type, but I would assure them that many complete novices have tackled the "Seal" camshaft (which is obviously twice as complicated as this one) with complete success,



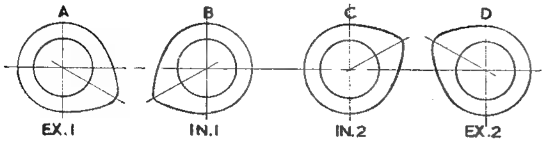
An example of the division plate and machining jig for the "Seal" camshaft, as used in the construction of the engine by Messrs. F. Bontor and R. C. Marshall

turn is mounted on ■ simple jig arranged to produce the required radius of eccentricity when mounted between the lathe centres.

I have not considered it necessary to repeat in full the directions for forming the cams which were given in connection with the description of the "Seal" engine, or to give ■ detail drawing of the eccentric turning jig, which differs from that of the latter only in its length and position of the clamps, to hold ■ shaft with four cams instead of eight. I have, however, reproduced the timing diagram, in terms of both crankshaft and camshaft angles; the latter can be used directly to mark off the division plate to be fixed to the camshaft. Note that in the event of the engine being reversed to run in the opposite direction, the sequence of the cam operations will also have to be reversed; the camshaft, incidentally, runs in the same direction as the crankshaft, simply by working to the directions given. It is only necessary to start off with correct methods, and observe due care and patience in carrying them out. Many inexperienced workers think these methods unnecessarily tedious, and try to find ways of side-tracking the problems involved; but on the strength of having made nearly all the mistakes of this kind possible in my time, I can say that short cuts do not pay. It is better to spend a week on doing ■ job properly, than to botch it up in half an hour, and afterwards spend ■ month in trying (often in vain) to get it to work!

I have usually recommended that the cams of i.c. engines should be case-hardenered, but there are admittedly some snags in this operation, and in more than one case I know of, a carefully-made shaft has been spoiled by becoming distorted in the hardening operation. It has, however, been found that in engines not designed for racing

performance, the stresses on the cams can be kept fairly low, and unhardened cams will give quite good service if the tappet faces are hardened and polished, and lubrication is good. In such cases, an alloy steel of fairly good wearing properties is obviously better than mild-steel, and I have had success with cams machined from a nickel-chrome car axle, which although very tough, is not unduly difficult to machine. An alternative is to get the cam surfaces electro-deposited with a thin layer (not more than 0.005 in.) of hard chrome, a process now extensively employed in production practice, and catered for by several specialist firms.

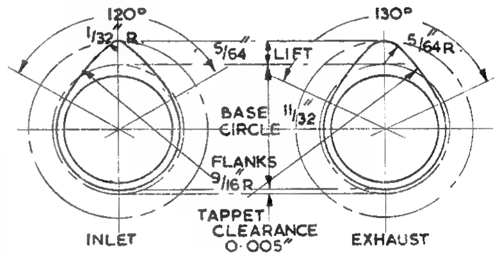


RELATIVE POSITION OF CAMS

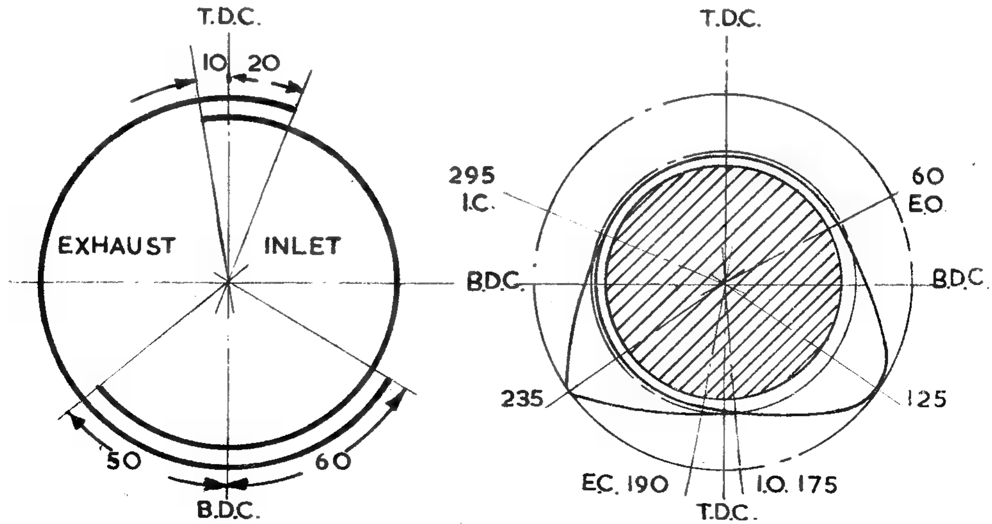
Camshaft Bushes

These are turned from bronze and are quite straightforward to machine. The bush at the timing end is pressed in from the inner side of the timing housing and the latter from the flywheel end of the camshaft tunnel. It will be seen that this bush has a closure on the end, which is specified as fitted after assembly, the object being to enable the two bushes to be previously line-reamed in position; but if desired, the bush may be made with a blind bore, deep enough to ensure clearance for the end of the shaft, and finished with a D-bit, as an alternative. When the bush is fitted it will be found that it fouls the edge of the main bearing housing flange; the obvious remedy is to file or machine away one or both the flanges to provide clearance at this point. Both camshaft bushes have oil holes, about $\frac{1}{16}$ in. diameter drilled in them obliquely from the chamfered end into the bore, the burrs inside being carefully cleared before attempting to fit the shaft.

Most heavy-duty marine engines have a centre bearing for the camshaft, and if desired, it is possible to reproduce this feature, though it is by no means a practical necessity, as the cam-shaft is quite well supported by the end bearings. The centre bush must of course be split, and can be machined in the same way as described for the centre main bearing, but without flanges; it is simply a split sleeve $\frac{3}{4}$ in. long, $\frac{9}{16}$ in. outside diameter and $\frac{5}{16}$ in. bore, the top half having a locating hole in the centre to take the piloted end of a 6-B.A. set-screw inserted from the top of the crankcase; this must not bear hard on the bush, but simply prevent it from turning. The ends of the bush should be chamfered externally and oil holes drilled obliquely from the top corners.

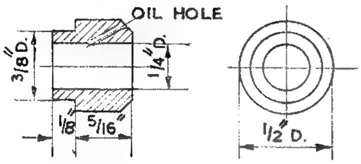


CAM CONTOURS

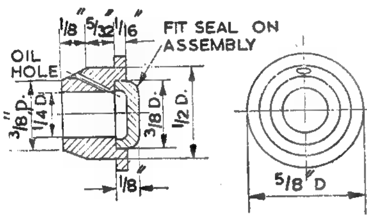


Timing diagrams, in terms of crankshaft and camshaft angles respectively

The taper fitting of the spur gear to the camshaft should be carried out just as carefully [redacted] that of the flywheel on the main shaft, but in this case keying is very desirable, as the relative location of the parts must be quite positive, and in the event of the drive slipping, the resultant dislocation of the timing might cause one of those "mystery troubles" which are unnecessarily prevalent in i.c. engines and often earn them a bad name for unreliability. The keyway in this case may be cut with one of the



CAMSHAFT BUSH, TIMING GEAR END.
1 OFF. BRONZE



CAMSHAFT BUSH FLYWHEEL END.
1 OFF BRONZE

tiny milling cutters with shanks to fit dental drills; there is no standard Woodruff cutter small enough for this job. When the camshaft is temporarily assembled in its bushes, and the gear wheel attached, it should run freely and have just [redacted] barely perceptible amount of end play, but no more.

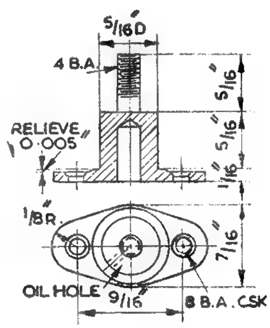
Idler Stud

This is made from mild-steel to the dimensions shown, and the base flange has two holes drilled to take [redacted] B.A. countersunk screws for attaching it to the face of the timing housing. The journal should be made a neat running fit for the idler pinion, with [redacted] very high finish, and long enough to permit slight end-play of the pinion. If the latter is of case-hardened steel, the stud may be left soft, but otherwise it will be desirable to harden it.

With the camshaft and crankshaft in position, complete with timing gears, the idler gear with its stud may be adjusted on the plate to give correct meshing. It will here be seen that slight discrepancies in the pitch diameter of the gears can be allowed for, and this embraces the possibility of using gears which are not cut to standard diametric pitch, so long [redacted] they are approximate in size and provide the necessary two to one ratio of reduction. A simple clamping plate, held down by bolts through two of the holes for the timing case fixing screws, may be used to hold the stud in position while adjusting the mesh of the gears and marking the location of the flange fixing screws, after which the holes for the latter [redacted] drilled and tapped in the housing face.

It will be noted that an oil hole is drilled in the hollow journal; the exact position of the latter cannot be indicated on the drawing but it should be [redacted] the underside when the stud has been secured in position. The hole communicates with the concentric hole in the stud, and [redacted] similar hole should then be drilled in the housing, preferably sloping upwards towards the inside face, so as to act [redacted] catchment for oil splashed about in the crankcase. This method of lubricating the idler has worked quite well on the "Seal" engine, and it may be mentioned that oil feed from the inside is highly desirable, if not essential, for any gear, pinion or wheel which runs at high speed on [redacted] stationary axle; the provision of the usual oil hole in the outer member is useless, as the oil is thrown out by centrifugal force.

The outer end of the idler stud passes through the wall of the timing case, where [redacted] nut is fitted which helps to secure it in position, and a problem arises here, how to ensure that this hole is correctly lined up when the position of the stud is indeterminate. This can, however, be solved quite simply, and the method which I recommend is to set up the timing housing with the stud in position, in the four-jaw chuck, so that the latter runs central within [redacted] few thousandths of an inch, and the housing is true on the face to similar limits. It will be necessary to hold the housing by the tips of the chuck jaws, so that the face is clear. The idler stud is then removed from the housing, without shifting the latter in the chuck, and the timing case attached in its proper location by temporary screws or bolts.



IDLER STUD
1 OFF M.S. C.H.

It will now be possible to spot the position of the hole in the casing with [redacted] centre-drill, following it up with the clearance size hole for the 4-B.A. stud end, and also spot facing the boss. When the casing is fitted to the housing, with the idler stud in place, it may be found necessary to spot face the inside of the hole to enable the casing to fit properly at the joint face, or on the other hand, there may be [redacted] gap at the shoulder of the stud, which should be filled with a washer of suitable thickness, to prevent the casing being distorted when the nut on the stud is tightened.

(To be continued)

A Double-Acting Twin-Cylinder Feed-Water Pump

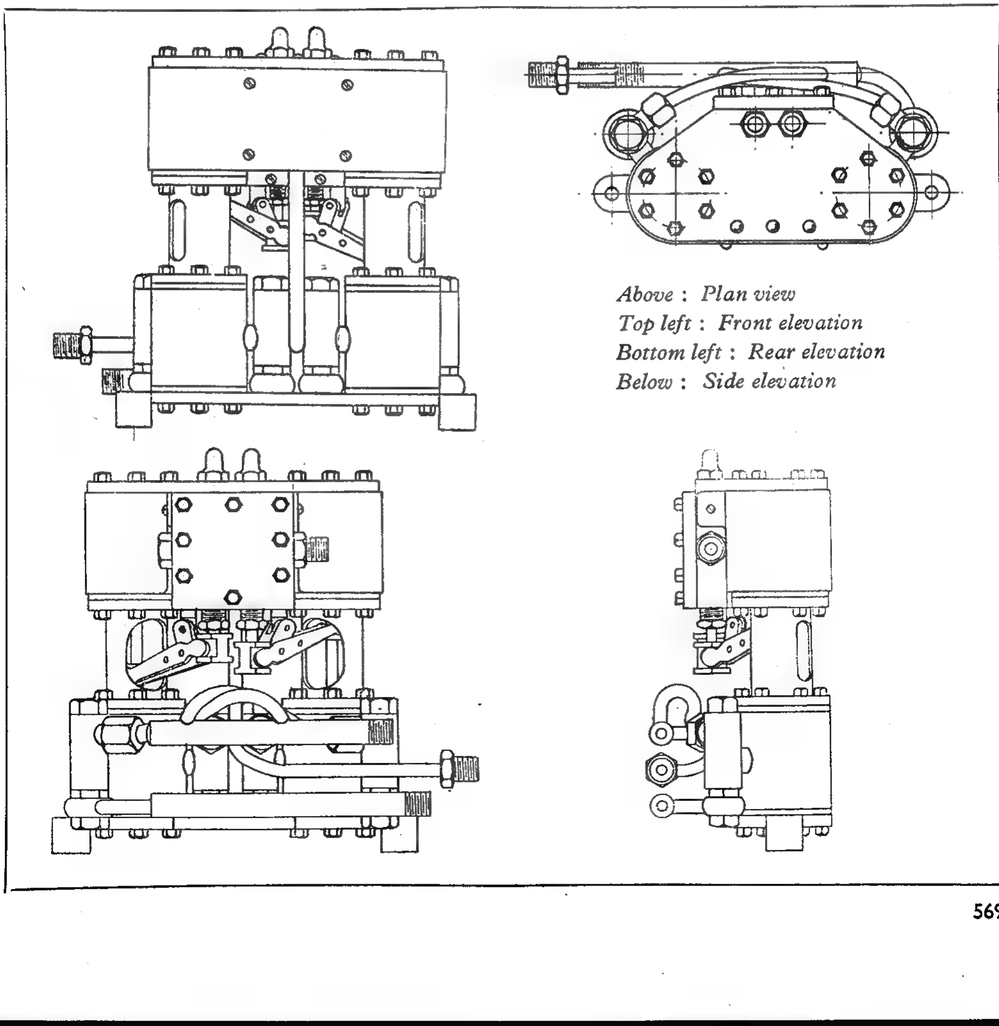
by J. I. Austen-Walton

FOR almost as long as I can remember, the biggest and most acute need of the steam plant user has been some reliable and efficient means of getting water into the boiler.

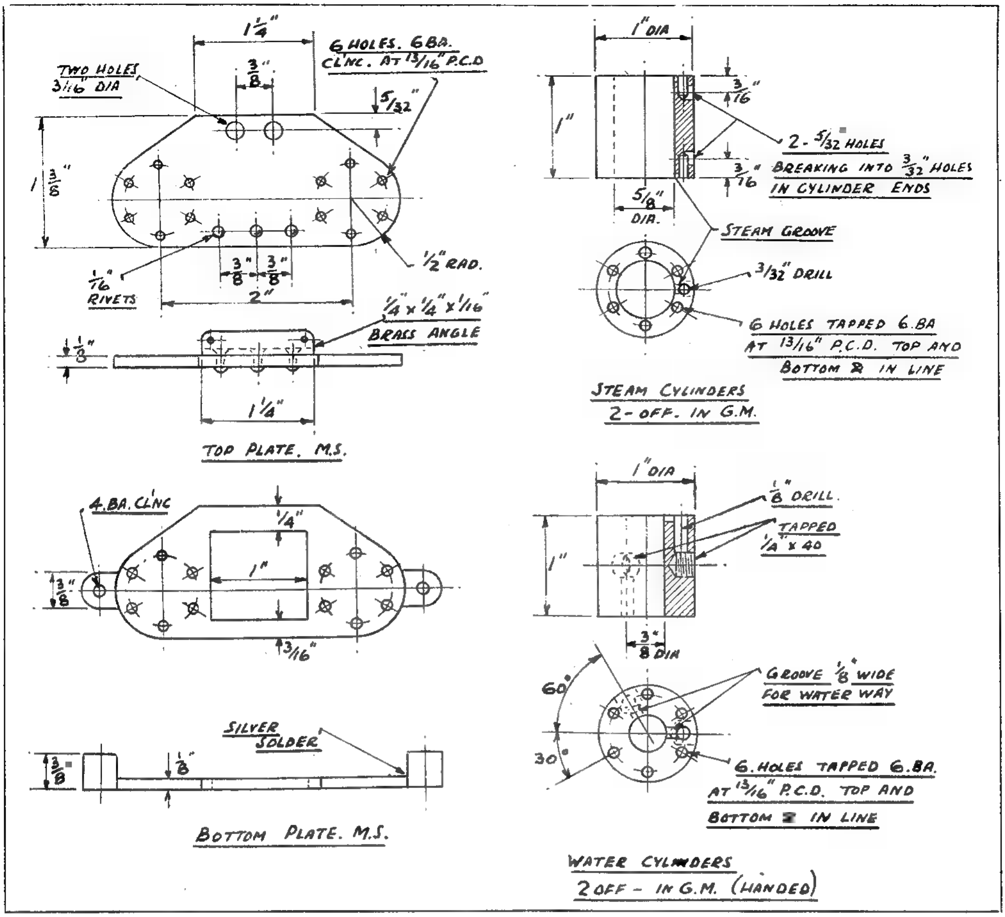
Most of us have used, and for that matter, still use the most reliable method of all—the hand-pump; and from that most humble expedient of all, a number of other methods have been devised, most of them successful, up to a point.

I do not wish you to think that I condemn these other methods out-of-hand, but I would like to remind you of some of the inherent weaknesses that have been recognised by steam boiler operators when, more often than not, they have been forced to use these alternative systems, or have placed themselves in a position where correct and safe working has depended entirely upon their continued operation.

Take the injector for example; a great deal of research has gone into the development of this mechanism, especially for use with the small locomotive, and the sizes and forms of the injector cones are no longer a matter of pure guesswork. That worried exclamation: "It worked *perfectly* yesterday," is still heard from time to time, yet it may have nothing to do with the injector itself. Distressed operators or drivers go to great lengths to explain that a mere speck of dirt in the jet will upset these temperamental things, and I am all sympathy. But that is not all; every injector has some definite range of pressure



Above: *Plan view*
Top left: *Front elevation*
Bottom left: *Rear elevation*
Below: *Side elevation*



in which it may be guaranteed to work, and above or below this known range it is not against stopping altogether or scalding your feet without warning.

What, then, are the main requirements of the injector? First of all, a good supply of hot dry steam, an easy running supply of *clean*, cold water, and last but not least, a cool location for the injector itself. Given these conditions and the love of cleaning injector cones at frequent intervals, you should get by fairly well.

Now what have we in the way of other methods? They all come in the pump family in some form, and, in the case of the small locomotive it appears first in the shape of the good old standby hand tender pump. When everything else fails, the wretched driver can be seen at almost any track meeting, at some time or other, furiously operating the pump handle and anxiously watching the gauge-glass during the performance. There is nothing less like realism than the man who is compelled to feed his engine via a piece of clanking tin, sticking out of the back of the tender.

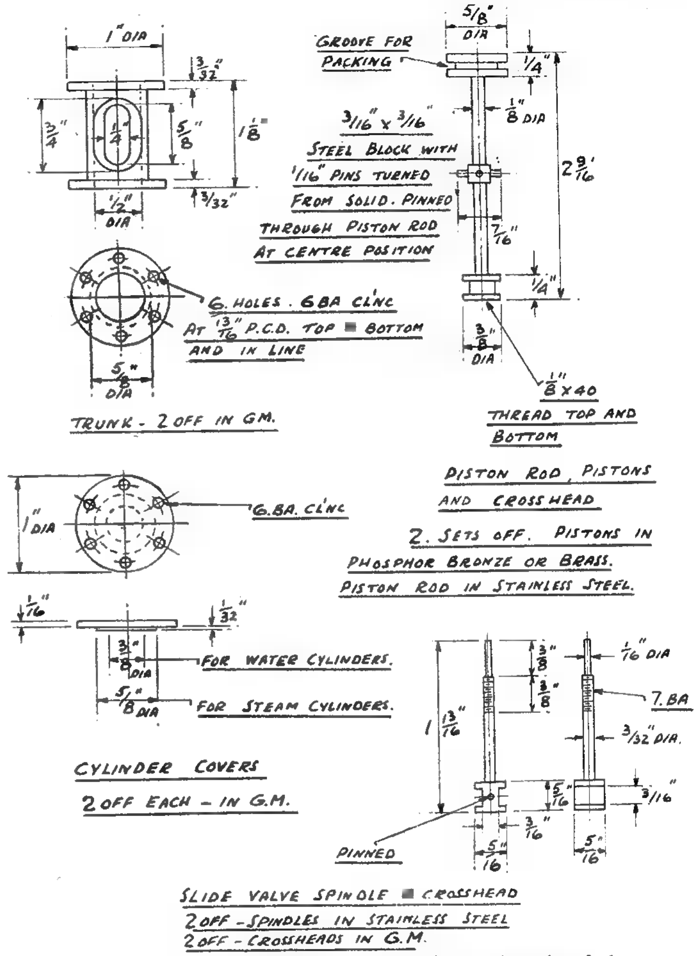
Next to this we have the axle-driven pump which is as reliable as the hand-pump in most cases, but not very intelligent. By this I mean that when the engine is on the run, it does its job well; very often it works too well, and that's how the bypass valve got invented. But if a body has to wait on the track, and the water is only a quarter glass, then other means must be sought.

That is where we come to the donkey pump, and a number of forms have been devised, many of them quite successful. When first I decided to settle the specification for a pump, I considered the following features to be essential:

It should be self-starting from cold, and from any position; it should clear its own condensate and run on wet or dry steam indefinitely; there should be complete freedom from springs and tripping mechanisms, and *both* strokes of the steam cylinder should do useful work, suggesting double action in the pump department, thereby avoiding steam waste on the return stroke. All these points add up, more or less to the Worthington pump idea, so it was by no means an original idea.

But I wanted to do more than this; I hoped to produce a pump that anyone could make, if necessary, without the use of castings, and with

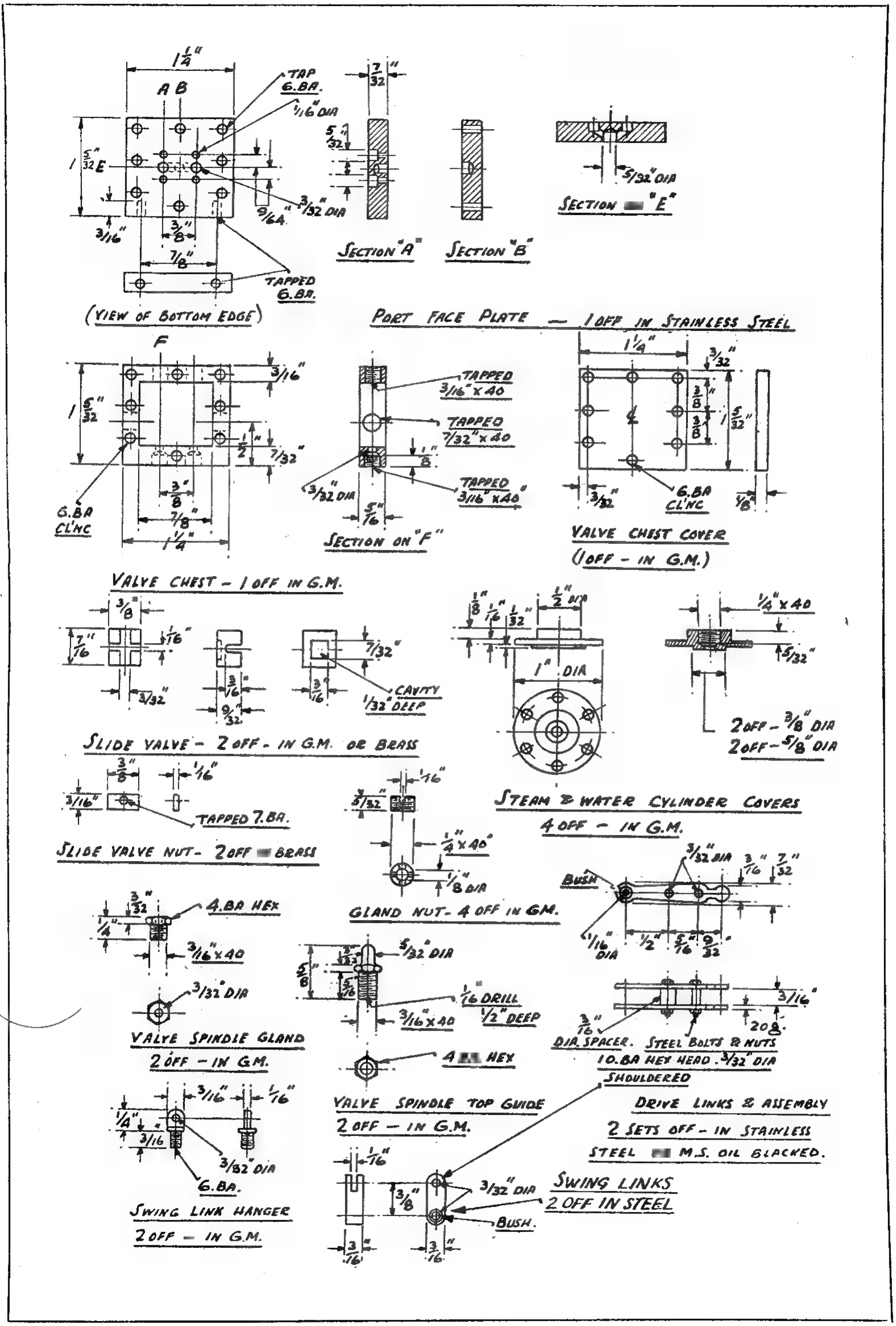
the minimum of working parts. So I set to work, and here you see the result. Altogether, a number of pumps were made, varying cylinder and pump bores tried, and the most promising unit was put to work. The first idea was to try it to destruction which didn't take very long, mainly because no lubrication system was fitted to it, and this gave me the idea of making ■ pump that would need no lubrication. The idea worked well, and after the alterations some 500 hours of work under actual steaming conditions left the pump untouched as far as mechanical wear was concerned. That was the answer; so it became established in its present form, and all I have to do is to describe the methods employed in building it.



We will start off with the steam cylinders and the pump bodies; these are just plain turned and bored parts in either gunmetal or phosphor-bronze, and in both cases the bores should be concentric with the outside diameter, and both square with the faced ends. Now let us make up ■ simple jig to drill the six stud-holes round the top and bottom of these parts. Suppose we take a piece of steel bar and chuck it; turn it down to the diameter of the cylinder outside, and leave a spigot ⅜ in. diameter by about a ¼ in. long, projecting. If we have a dividing-head and a drill spindle for the lathe we can then drill the six equally-spaced holes at the P.C.D. specified, afterwards parting off the piece with a top plate or disc about ⅛ in. thick. If you have no drill spindle you can at least turn a thin scratch-line at the desired P.C.D., and divide it up with a change-wheel on the mandrel, and an improvised plunger stop, and drawing the point of the turning tool across the face of the work to mark the six intersections. When the jig piece has been parted off, it is only a matter of patience to get a centre-punch dot exactly on each intersection, and to carry out the drilling operation which must be done with great care.

The advantage of making the jig this way lies in the fact that the spigot is dead concentric with the series of holes. The water pump barrel has ■ ⅜ in. bore, which will accept the spigot. The steam cylinder has ■ ⅝ in. bore, and the trunk member has ■ ½ in. bore, therefore, two loose collars are needed to slip over the spigot of the jig when you come to drill these other parts.

You should harden the jig; case hardening will be quite satisfactory, and then you can set about drilling the stud holes. The most important thing of all is to make sure that the top set of holes in any part, is exactly in line with the lower set, and this applies to all three different parts. Now there is more than one way of doing this, but the following method may appeal to you. Take the steam cylinder and pump bodies, and with the aid of the jig, drill one set of holes about halfway through the length of the part; the trunk member, having thin flanges will, of course, be drilled right through one flange. Now take a cylinder, and chuck it in the four-jaw chuck so that one of the drilled holes runs dead true. Put the drill in the tailstock chuck and drill right through to the other side. If the part is now taken out of the chuck, the jig can be tried over the hole where the drill has broken through, and if this mates up correctly you can insert a temporary peg and continue to use the jig in the normal way. If your chucking has been done correctly and the drill has not been allowed to wander, you will find that the remaining drilled holes from the opposite end will break through into the first set of holes almost like magic.



TAP 6.BA.
1/16" DIA
3/32" DIA
TAPPED 6.BA.
(VIEW OF BOTTOM EDGE)
SECTION "A"
SECTION "B"
5/32" DIA
SECTION "E"
PORT FACE PLATE — 1 OFF IN STAINLESS STEEL
6.BA CL'NC
TAPPED 3/16" x 40
TAPPED 7/32" x 40
TAPPED 3/16" x 40
3/32" DIA
SECTION ON "F"
VALVE CHEST — 1 OFF IN G.M.
6.BA CL'NC
VALVE CHEST COVER
(1 OFF — IN G.M.)
CAVITY 1/32" DEEP
SLIDE VALVE — 2 OFF — IN G.M. OR BRASS
TAPPED 7.BA.
SLIDE VALVE NUT — 2 OFF BRASS
1/2" DIA
1" DIA
1/4" x 40
2 OFF — 3/8" DIA
2 OFF — 5/8" DIA
STEAM & WATER CYLINDER COVERS
4 OFF — IN G.M.
1/4" x 40
1/8" DIA
GLAND NUT — 4 OFF IN G.M.
4.BA HEX
3/16" x 40
3/32" DIA
VALVE SPINDLE GLAND
2 OFF — IN G.M.
5/32" DIA
1/16" DRILL 1/2" DEEP
3/16" x 40
4 HEX
VALVE SPINDLE TOP GUIDE
2 OFF — IN G.M.
BUSH
3/32" DIA
1/16" DIA
3/16" DIA SPACER.
STEEL BOLTS & NUTS
10.BA HEX HEAD. 3/32" DIA
SHOULDERED
DRIVE LINKS & ASSEMBLY
2 SETS OFF — IN STAINLESS
STEEL M.S. OIL BLACKED.
3/32" DIA
6.BA.
SWING LINK HANGER
2 OFF — IN G.M.
3/32" DIA
BUSH.
SWING LINKS
2 OFF IN STEEL

Here is another system—quite simple and very effective, and it can be carried out on the drilling machine. Set the table of the machine so that, with the drill in the chuck and the longest component under it, you can feed right down to the table surface with $\frac{1}{2}$ in. to spare. Clamp an odd piece of $\frac{1}{2}$ in. thick steel plate, a couple of inches square or more, and quite flat, on to the table. Put a centring-drill in the chuck and make a starting-hole in the piece of plate; replace the drill and continue down almost through the thickness of the metal. Now make up a tiny steel peg or dowel that will drop into the hole, leaving about a $\frac{1}{8}$ in. projecting. After you have drilled all the components at one end, with the aid of the jig, and which you would do before this set-up, of course, you can stand each one with any hole over the peg and centre drill the opposite end, continuing with every hole (if your drilling machine is accurate) or reverting to the use of the jig, after the position of the first hole has been established. This latter method is better than the former in that it enables you to deal with the trunk member far more easily. Should you decide to drill off the peg system, you *must* be sure that no swarf or burrs prevent the component sitting fairly and squarely on the peg-plate, otherwise you will be " all at sea " from the very first hole. After doing the centring, you can remove the centre drill and continue with the size drill, still making use of the peg location.

Don't forget to drill all the holes to 6 B.A. tapping size, opening up the trunk member holes to clearing size later. If you have got so far without trouble, then you are well on the way.

Next, tap all the holes, and the through drillings make this much more comfortable in every way, after which you can continue with the top covers—both plain and glanded, turning these with the shallow spigots for their respective positons. When you come to drill the six holes in these you can start on the glanded covers first, and, as the *outside* spigot is made to fit inside the trunk member at each end, steam type at the top and water type at the bottom, you can use the trunk member itself to start the drilling through the six stud holes, jig fashion. The drilling of the plain covers should be left until the top and bottom steel plates are made, when they may also be used as a drilling-jig in a similar way. Therefore, make the steel plates the next job.

Choose two nice pieces of plate that are quite clean and flat, marking out, cutting and filing them to shape while clamped together, and making the square aperture in the lower plate separately. Keep the sweep that follows the line of the top of the cylinder as accurate as possible, and taking one plate only, clamp the original drill jig in position one side, making sure that the holes are disposed as shown on the drawing, and drill through, afterwards carrying out the same operation the other side. Now clamp the two plates together the way they will eventually *face each other*, making, if necessary, some mark that you will recognise on the two faces, and use the drilled plate as a jig to drill the other part. If the plain covers are now clamped to the steel plate, one by one, you can make further use of the temporary drilling-jig, and a line up from top to bottom should exist. It is advisable to assemble the eight parts with temporary screws to see if things continue to go according to plan; you may find that slight errors permit assembly when in one particular position, indicating the need for number or letter stamping down each side in a predetermined line, and as an aid to future assembly. In any case, don't pass the job if there is any binding or pinching, of if there is any tendency for the parts to turn or rotate as they are built up. In this case, you may be able to cancel out the twist by slotting the holes *radially* and *equally* from both sides of the top or bottom plate, but *not* by slotting the holes in the turned components; that would lead to even more trouble later on.

Let us assume you have got this part right; the next thing to do is to drill the steam-passages in the cylinders, and the water-ways in the pump bodies, as well as to make sure that their positions agree with any markings which may have been made for assembly guidance.

The water-ways in the pump comprise two drilled holes at a mid-way position in relation to their length, and these are broken into by two other holes drilled from *opposite* ends of the barrel. *It does not matter which one goes up and which goes down so long as they are opposite ways*; but the angle of the side entries *is* important, as these are tapped and have the clack-boxes screwed into them, and it would look bad to see them sticking out at odd angles. If you have drilled these parts and tapped the water pump holes, we can carry on. The port-face plate is made from stainless steel, and no other material should be used if you wish to run the pump without lubrication. There is very little machining to be done, and this is drilling and tapping of the simplest order. You will see that the " ports " are just drilled holes, spaced in the same way as ports. There is no high speed working, no lap, no lead or other complication to worry about, and a wide or conventional type of port would only increase the load on the slide-valve and tend to promote extra wear and tear.

The valve-chest and cover should also be made up, with all the drilled and tapped holes as shown, and put together with service screws or bolts. Complete the drilling of the other holes in the top steel plate, and, making up temporary studs to take the place of the valve-spindle top guides, bolt the steamchest unit to the top plate. Now assemble the two steam cylinders and their plain covers, again using temporary screws or studs, fixing these to the top plate as well. This assembled unit now forms a rigid and sturdy jig for silver-soldering in the " serpent's nest " of pipes that connects the steam passages with the back of the port-face.

Just in case it is not abundantly clear on the drawing, this is the order of the connections. Holding up the unit with the back of the port-face towards you, the top left-hand steam passage goes to the top right-hand hole in the port-face, and the bottom left-hand steam passage goes to the bottom right-hand hole in the port-face. The top right-hand steam passage goes to the *bottom* left-hand hole in the port-face, and the bottom right-hand steam passage goes to the *top* left-hand hole in the port-face. The exhaust

(*Continued on page* 577)

Novices' Corner

Mandrels—Taper, Stub and Screwed

MANDRELS are used for mounting work which must have the periphery turned truly concentric with the bore. For example, it is essential that both the bore and the outside diameter of a bearing bush should be concentric and it is, therefore, sometimes though not necessarily always convenient, to machine these components on a mandrel to ensure concentricity.

After a piece of suitable material has been selected and mounted in the chuck, the bore of the bush is machined accurately; the blank which will form the bush is then parted off to the correct length and mounted on a true-running mandrel which is run between centres so that the outside of the bush can be turned to size. This method of machining bushes and similar parts not only ensures accuracy but also materially increases the speed with which a batch of identical components can be produced.

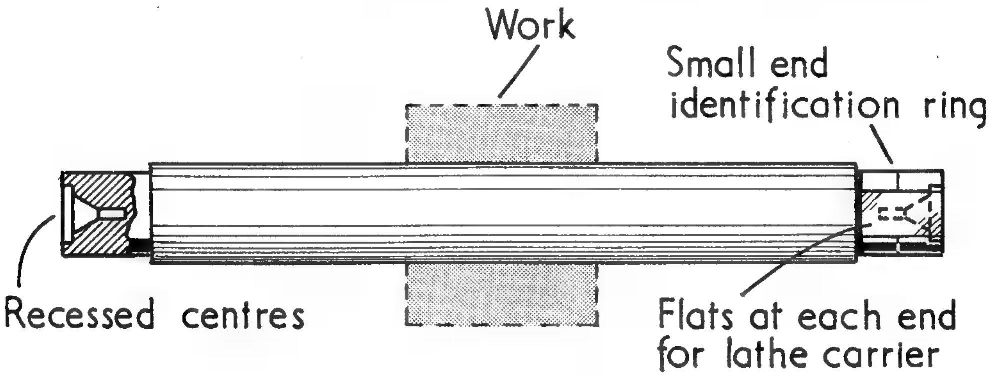


Fig. 1. A taper mandrel

Taper Mandrels

Mandrels are accurately-ground hardened steel cylindrical bars, and they are made in various diameters and lengths. They are not truly parallel, but have a taper of some 0.0005 in. per inch of length and are ground with one end slightly smaller than their nominal size. This allows the mandrel to enter the work and to be pressed in with sufficient force to withstand the cutting action of the tool.

The form of mandrel most commonly used is that illustrated in Fig. 1, where it will be seen that each end is provided with centre holes so that the mandrel can be mounted between the lathe centres. Both ends of the mandrel are reduced in diameter and are provided with a flattened portion to act as an abutment for the screw of the lathe carrier which is used for driving purposes. It will also be seen that a narrow ring is turned on one of the reduced portions. The purpose of this ring is to indicate to the user which end of the mandrel is the small one.

The accuracy of work turned on a mandrel of this type is dependent upon the device running true between the lathe centres; therefore, quite apart from the true running of the lathe centres themselves, the centred ends of the mandrel must remain undamaged. To obviate this possible source of error the ends of the mandrel are recessed and the centres are then formed, as seen in the illustration, on a face which cannot readily be reached by a hand hammer, a tool which is, unfortunately, too often the means by which the mandrel is driven into the work.

In workshops where much mandrel work is undertaken, a proper press is provided for forcing the mandrels into and out of the work. These presses are adjustable and have work tables furnished with varying sizes of holes which allow the mandrels to pass. In the small shop, however, a hammer is usually employed, though it is sometimes possible to use a large vice to press the mandrel into the work. When a hammer is used it should be made either of copper or brass, or, alternatively, a pad of soft metal should be interposed between the head of the hammer and the end of the mandrel. If this precaution is not taken, the end of the mandrel will, in time, become deformed. Although, initially, this may not impair the mandrel's accuracy, this deformation will present an unpleasing and neglected appearance which no self-respecting craftsman should tolerate.

When mounting the mandrel between the lathe centres, care must be taken to make sure that the centred ends are quite free from dirt and chips and are well oiled. In addition, the

mandrel must be so placed that the direction of the cut tends to force the work towards the large end. The identification ring previously mentioned will serve as a datum for this purpose and, whatever may be the direction of feed, the tool must travel away from this ring.

After a mandrel has been used it should be cleaned and put away carefully. Commercially-made mandrels are expensive and high-class pieces of equipment which deserve, and indeed must have, good treatment. Some time ago, we were presented with a number of mandrels. Unfortunately, in the hands of a previous owner they appear to have been put in a box along with soldering equipment, or had otherwise come in contact with a corrosive liquid. As might be expected, after cleaning, the mandrels were found to be deeply pitted and useless for accurate work. Had these tools received proper care in the first instance we should have been in possession of some useful equipment ; instead, we now have a notable example of careless treatment. There is, here, a moral concerning the indiscriminate use of rag in the workshop. It is fatally easy to pick up the wrong one and wipe some tool with it, only to discover, too late, that the rag in question has been used previously to mop up a corrosive such as soldering flux. Rags which have been used for this purpose should always be destroyed before they can do damage.

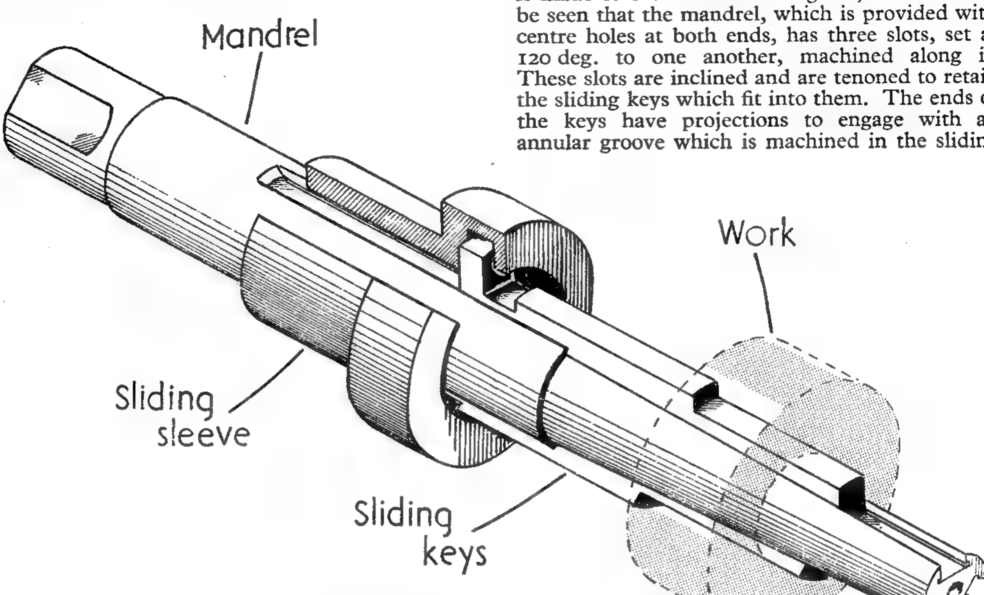


Fig. 1A. *The Le Count expanding mandrel*

Expanding Mandrels

If the size of the work is such that it cannot be accommodated on mandrels of normal inch fractional sizes, an expanding mandrel may be used. Some of these mandrels are adjustable for diameter over a narrow range only, whilst others, of which the Le Count mandrel is an example, have a much wider range. A typical example of the make mentioned will adjust so that components having bores varying from ½ in. to 1 in. in diameter can be mounted for machining. Expanding mandrels are used in the same way as the plain variety, that is between lathe centres.

The construction of the Le Count expanding mandrel will be readily understood if reference is made to the illustration Fig. 1A, where it will be seen that the mandrel, which is provided with centre holes at both ends, has three slots, set at 120 deg. to one another, machined along it. These slots are inclined and are tenoned to retain the sliding keys which fit into them. The ends of the keys have projections to engage with an annular groove which is machined in the sliding sleeve, the latter being a sliding fit on the mandrel.

The keys, which are numbered so that they can be replaced in their correct slots in the event of their being accidentally misplaced, are ground truly concentric with the running centres of the mandrel after all the parts of the device have been assembled together. As the slots are also accurately machined it follows that, by moving the sliding sleeve along the mandrel, the keys can be made to expand outwards and hold securely, and concentrically, any work which is within the capacity of the device.

The use of a press is advisable when mounting work on mandrels of this type, the more so since, in manufacture, no attempt is made to protect the centres in the manner described previously with reference to plain taper mandrels. If a hammer must be used, then one having a soft metal head is essential, and in default of this, as previously mentioned, a soft metal pad must be interposed between the mandrel and the hammer-head. It is not desirable to drive on the ring of the sliding sleeve ; for if this sleeve is deformed in any way, the positioning of the keys in relation to each other may be lost and the accuracy of the tool destroyed.

Stub Mandrels

A form of mandrel which the lathe user can make, as occasion demands, is the stub mandrel.

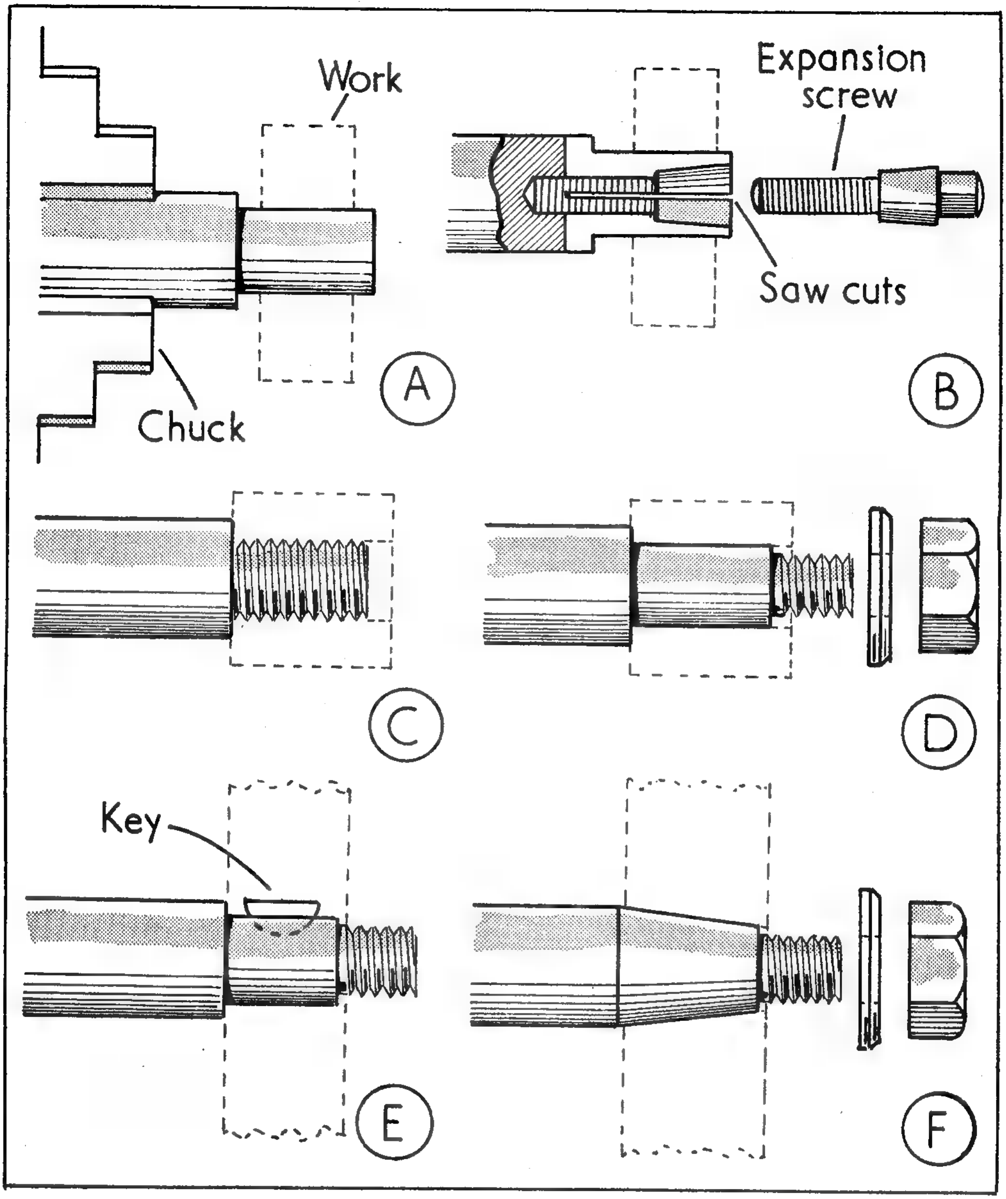


Fig. 2. Six forms of stub mandrel

This mandrel has various forms, [redacted] illustrated in Fig. 2A to F. It may either be plain, as in Fig. 2A, or of expanding form, [redacted] shown in Fig. 2B, so that bushes or small wheels which need machining on their periphery can be mounted for turning. An expanding mandrel of the type shown will accommodate [redacted] series of similar components whose bore diameters vary slightly. It is, therefore, probably the most convenient way in which to hold such parts for machining. An easily-made expanding stub mandrel is illustrated in section in Fig. 2B. This mandrel was described by "Duplex" in their article "Pipe Fittings," published on July 13th last. Reference should be made to this article for further information.

Fittings which are threaded internally may be mounted for machining on [redacted] screwed mandrel of the form seen in Fig. 2C. The device is screwed for the whole of its length and the work abuts against a shoulder which should be of ample size. The thread must, of course, be accurately cut.

A threading operation carried out by means of a tailstock die-holder will suffice for light work, but may not prove satisfactory if a large component is to be mounted. In this event, the thread must be formed by screw-cutting in the lathe.

Another variant of the plain mandrel is shown in Fig. 2D. Here, the work is mounted upon a parallel portion which is made a firm push-fit in the bore of the work. The threaded end of the mandrel, which need not, in this instance, be cut with meticulous accuracy, is used to accommodate the nut and washer by means of which the work is secured against rotation by nutting against the abutment shoulder.

In order to transmit the power required when turning large work, a key is sometimes fitted into the parallel part of the mandrel. But this device can, of course, be used only when the parts to be machined are themselves keywayed as an element in their general construction. This arrangement, which is illustrated in Fig. 2D, is very suitable for the production of a batch of identical components, such as the blanks for gear wheels, in which concentricity of the bore and the rim is essential.

One further type of screwed mandrel is sometimes used. This is of conical form and has a taper which corresponds with that turned in the bore of the part to be machined. The screwed portion allows the work to be firmly secured by means of a nut and washer. The arrangement is shown in Fig. 2F.

Making Stub Mandrels

Stub mandrels fall into two classes. In the first category are those which are made specially to complete some particular piece of work and are, thereafter, not used again. In the second class are those mandrels which are accurately machined to a definite size so that they can be mounted either in a collet chuck, or set to run true in the four-jaw independent chuck, and used repeatedly.

The making of hardened mandrels is scarcely practicable in the small workshop, so it is usual to machine these devices from mild-steel of a good quality. With reasonable care soft mandrels exhibit good wearing properties.

To make a stub mandrel, a suitable piece of material is gripped in the chuck and the required portion is turned down until the diameter measures about 0.001 in. larger than the bore of the component which is to be accommodated. The seating for the work is then polished with a fine file and subsequently with a strip of worn fine emery-cloth, until the work can be wrung on to the mandrel and held firmly. The aim of the operation is to produce a work seating which is slightly tapered and able to hold the work without slipping. It must, however, be emphasised that these final processes need care, and that over-generous application of the file in the first instance will undoubtedly result in the mandrel becoming undersized and useless.

When it is desired to use a mandrel but once, it is only necessary to machine the work seating ; but mandrels which are needed for repeated use must be machined both on the work seating and on that portion which is to be gripped in the chuck, for only by doing so will concentricity of the two parts be assured.

To this end, the piece of material which is selected must be long enough and should be set in the chuck with sufficient projection to allow the complete mandrel to be machined in one operation, a procedure which will probably entail the use of the back centre to support the work.

Mandrels of the type shown in Fig. 2D have their work seatings turned parallel and to a size which will permit the work to be pushed firmly into place. No polishing should be necessary other than to correct any slight enlargement of the parallel portion.

When using mandrels for turning purposes, care must be taken to see that they are of a size which is commensurate with the work. As, in nearly every case cited, friction is used to transmit power to the work, the surface area of the mandrel in contact with the component needs to be large or slip will be experienced. If the mandrel tends to rotate in the work both mandrel and component may be damaged.

No attempt should be made to part-off work mounted upon a mandrel unless the latter is specifically designed to permit this. A hardened mandrel will quickly blunt any tool brought into contact with it, whilst a soft mandrel will be damaged if the tool cuts into it.

A Double-Acting Twin-Cylinder Feed-Water Pump

(*Continued from page* 573)

pipe goes to the centre hole in the back of the port-face. If the whole lot were to be reversed, it would work just as well, because it is only one cylinder that has its port positions inverted, and both cylinders use the opposite sides of the port plate—this being done to allow the mechanical linkage to operate the valves "without crossing hands," so to speak.

Both the port-face plate and the cylinders have "pockets" drilled to take the ends of the pipes which should be fairly thin-walled and well annealed. You may have to fiddle about quite a bit getting these to the right shape and set, but once made, they spring into place without too much trouble, and will "stay put" during the silver-soldering operation. You may find it helpful to wire the "nest" together when you are ready to apply the blowlamp, and should some of the bends be less elegant than those on the drawing—don't worry too much. So long as there are no absolute kinks or bad flats in the pipes, the pump will function quite well. Cover the whole inside well with "Easyflo" flux, heat up evenly, touching in the five pipe joints on the port-face, and the four connections on the cylinder walls. Don't use too much solder or it may start to run round the ends of the pipes, blocking them up ; then you *are* in trouble.

(*To be continued*)

Queries and Replies

Enquiries from readers, either on technical matters connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by stamped, addressed envelope, and addressed: "Queries Dept." THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.

Queries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge.

More involved technical queries, requiring special investigation or research, will be dealt with according to their general interest to readers, possibly by a short explanatory article in an early issue. In some cases the letters may be published, inviting the assistance of other readers.

Where the technical information required involves the services of an outside specialist or consultant, a fee may be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.

Only one general subject can be dealt with in a single query; but subdivision of details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered within the scope of this service.

No. 9870.—Transformer for Carbon Arc F.W.N.S. (Yorks)

Q.—We have used a modern mercury-quartz ultra-violet lamp with success for over a year. Its continued use produces a honey-yellow Alpine-type tan, but we are rather intrigued by the idea of the deep tropical-bronze kind of tan given by the high power carbon arc—70-90 volts and about 30 amps. would seem to be indicated for the arc. We should much appreciate your advice on the manner of obtaining this. We believe a transformer to supply this would have a primary winding carrying about 12 amps. at 230 volts, a.c. Such a transformer would surely be huge, and, therefore, expensive to construct. Accumulator batteries and d.c. generators are, we think, out of the question because of expense. Any tips you could give us on the construction of such a large transformer, if that is the only practicable solution, would be welcomed. Also, would such a transformer stand the "shorting" as the carbons were touched to start the arc in the first place? We have vaguely heard of the "negative resistance" of an arc, although such a thing doesn't seem possible. If this were so, it would be even worse than shorting, so perhaps you could tell us how this would affect the design of the transformer.

R.—The arc working voltage would be 60-70 volts, a secondary voltage therefore of 80 would be sufficiently high for the purpose in view. For an output of 3 kW you would need a core area of approximately 9 sq. in., two limbs 3 in. × 3 in. could be chosen allowing for a window space of not less than 2½ in. × 2 in. The primary and secondary would be arranged on the respective limbs. The gauge of wire suitable for both primary and secondary would be 12-s.w.g. double cotton covered copper wire. The turns for the primary would be a total of 204. For the secondary, the total turns would be 72, two wires being wound in parallel, that is, two wires together. The bobbin thickness can be to $\frac{1}{16}$ in. and also the cheeks. The winding will require to be varnished and baked after assembly. Any insulating varnish, excepting shellac, may be used. Although the construction is simple in itself, it would not be so easy to wind this gauge wire without some form of winder, a lathe for example. If bobbins are not used, the coils may be wound on a former, being afterwards insulated with Empire cloth and leatheroid to a thickness of not less than 30 mm. So far as the wire is concerned, this could be obtained from any maker of winding wires. The question of stampings for the core may not be so easy, but we suggest that you contact Messrs. Sankey, Bilston, Staffs, explaining what your required for your supply. No transformer will stand short-circuting, especially if of large size, so means must be provided to prevent this. For the operation of arc lamps it is usual to provide a choke coil or resistance to limit the current which the arc may take at the moment of striking. In practice, it is usual to use a choke as the main current limiter (this is for economy) and carry out the final current adjustment by a small variable resistance. In any case it will be necessary to provide some kind of regulation, as the arc may be unstable under wrong current conditions according to the size of the carbons used.

No. 9862.—Pantograph Calculations P.V.D. (Bexley)

Q.—I wish to construct a pantograph and will be grateful for your help. Can you tell me the manner in which the multiplication is calculated. I wish to scale up some plans 1½ or 2 times, and although I know the general construction, I do not know for certain the controlling factors in size.

R.—The multiplication or reduction obtainable by means of a pantograph depends entirely on the ratio of the distance from the fixed pivot point of the lever arms to the tracer point and pencil point respectively, that is to say, assuming that the distance from the fixed pivot to the tracer point is 6 in. and that from the fixed pivot to the pencil point is 12 in., this will give a multiplication of 2, or in other words, produce a drawing twice full size. If the positions are reversed, the same ratio of reduction will be produced.

No. 9866.—The 15-c.c. "Seal" Engine J.B.T. (Hayes)

Q.—I am considering building a 15-c.c. "Seal" engine for installation in a 1/8 scale road vehicle. Before I embark, however, I would like you to answer the following questions :—

(1) Do you approve of opening up the cylinder bore to 11/16 in., bringing its capacity to 16.72 c.c.?

(2) In this case, would the crankshaft require an additional centre main bearing?

(3) Could the carburettor lift the fuel a maximum of 2¾ in.? If not, could you please give the maximum practical "lift" possible.

(4) Is this carburettor suitable for gravity feed with a maximum head of fuel of 3¾ in.?

(5) What is the maximum variation in fuel level possible to give a consistent power output without altering jet screw? (I am assuming this applies only to suction feed.)

(6) With the bore enlarged to 11/16 in., would the inlet-valves require enlarging?

(7) Have you any figures of b.h.p., torque and m.e.p. available for standard "Seal" engine?

(8) Is this engine suitable for long periods of running (up to about 10 minutes) hauling the driver on a trailer?

(9) Do you suggest a plate, or centrifugal clutch for this type of work?

R.—(1) It is quite in order to open out the cylinder bore of the "Seal" engine and bring the capacity up to more than 15 c.c. as suggested.

(2) It would be extremely difficult to introduce an additional centre main bearing in this engine, unless the crankcase design was altered to obtain the necessary space in between the centre cylinders. An extremely short centre bearing would be little more than useless. We do not think that it is necessary in this particular type of engine, but as an alternative, it would be possible to stiffen up the crankshaft dimensions, making the crankpins larger in diameter, though this would necessitate corresponding enlargement of the big-end bearings. There is, however, room in the crankcase for such enlargement.

(3) The amount of lift which can be obtained on the carburettor of this engine will depend very largely on the craftsmanship put into the engine. We have found that many constructors of small engines do not fit the inlet valves sufficiently accurately in the guides to prevent air leakage at this point, and this will very much impair the suction available for lifting the fuel. We have run engines of 15 c.c. with as much as 4 in. lift of fuel, but, generally speaking, we do not recommend that the fuel should have to be lifted more than 1 in. for engines of this type.

(4) Our recommendation for the feeding of the carburettor from a gravity tank would be to use a bird-feed system to a small reservoir, similar to a carburettor float chamber, adjacent to the fuel jet.

(5) By using this arrangement, there would be very little variation in level of the fuel at the jet. If, however, it is not used, we do not recommend a greater variation of level than about 1 in.

(6) Unless the engine is specially being tuned for high efficiency, there is no need to enlarge the bore of the inlet valves.

(7) No figures of b.h.p. torque and m.e.p. are available for this type of engine; the reason for this is that accurate testing of any small engine calls for very long and patient work on the test bench, and it has not been possible to secure the time for this.

(8) The engine is definitely suitable for long periods of running, so long as proper water circulation is kept up and the level of lubricating oil is also maintained.

(9) We suggest that a centrifugal clutch would be the most suitable type for using this engine in a model road vehicle, but it could, if necessary, have an overriding mechanical withdrawing gear similar to that fitted to some types of full-sized cars at the present time, which would enable it to be operated manually at any speed.

No. 9854.—Carbon Pile Voltage Regulator H.T.M. (Douglas)

Q.—Could you give me specific information on the carbon pile type voltage regulator?

R.—This is virtually a form of adjustable rheostat, which is capable of working continually under fairly heavy current conditions. It works on the principle of varying the resistance of carbon blocks or granules by applying mechanical pressure. The higher the pressure applied, the lower is the resistance, and the greater the amount of current transferred. Carbon pile voltage regulators are normally equipped with an electro-magnet, or solenoid, which is used to apply the pressure according to voltage in the circuit, and thereby provide automatic regulation.

No. 9867.—Converting to Shunt Motor G.B. (Newbiggin-by-Sea)

Q.—Could you please answer the following query with regard to a motor I have recently purchased? Details are as follows: Input, 24 volts, d.c., 21 amp., 0.3 h.p. Rating, 1-5 mins., 4,000 r.p.m. Armature, 2 in. long, 1¾ in. dia., 21 slots, depth ⅜ in. approx., width 7/64 in. approx. Commutator, 21 segments. Armature wound with 21-s.w.g. (?) D.C.C. Four-pole field (laminated) wound with ¼-in. copper strip (22-s.w.g. ?) Motor is series wound, has three terminals and is reversible.

I wish, if possible, to rewind the above to suit either 12.24 volts, a.c., 8-10 amps., or 12 volts, d.c., 5-7 amps. Can I leave the existing armature windings and rewind the fields, or must I strip the whole and rewind both?

R.—The current which your motor demands will depend upon the work it is called upon to do. Rewinding it in its present state would not help matters much unless you only want a small amount of power. The better plan would be to convert it into a shunt machine. As an experiment, the field coil should be rewound with a wire about half the present section and adding 50 per cent. extra turns per coil. All coils will be connected in series and connected in shunt to the brushes. If you require the motor for reversing, the field leads should be brought out and reversal carried out by reversing these leads only; in this case the terminal block will require to have four terminals.

PRACTICAL LETTERS

Model Submarine Engine

DEAR SIR,—The letter from Mr. Bristow asks how the submarine engine shown in the issue of July 20th works. The drawing indicates that looking aft at the engine the propeller rotates clockwise. This requires that the port side steam or air passage should be the exhaust to atmosphere. The starboard side passage admits surrounding compressed air into cylinder at same pressure as below piston allowing same to float with flywheel momentum until bottom of stroke, when air entry is shut off. Beyond bottom d.c., the port passage is opened to atmosphere, and the upward pressure difference provides the next turning effort. With a possible slight back pressure on dead centres, the engine would function satisfactorily.

Yours faithfully,
Wembley. W. H. TRIPP.

Shaping Spur Gears

DEAR SIR,—*Re* the article on gear generating by "Base Circle," I would like to point out a discrepancy in the method used.

The principle suggested is correct, but the involute of a gear tooth is not generated from its "pitch circle diameter," but from its "base circle diameter." Therefore, the disc (Part "C") should be turned to the base circle diameter—0.048 in.

Base circle diameter = 2 [pitch circle rad. $\times$ cosine pressure angle].

The most common figure for pressure angle is 20 deg.

I must congratulate our contributor on his practical article, and hope I have not confused my fellow readers with this correction.

Yours faithfully,
Halifax. K. HORSFALL.

Workshop Power Supplies

DEAR SIR,—I have been confined to bed recently with one of our middle-aged troubles (so my lathe tools, etc., will be able to cool down a little) and I have been reading bits of my "M.E." which ordinarily I should have probably passed over. Without wishing to offend your contributor in the August 31st issue, Mr. D. Blackhurst, I must confess a little shamefacedly that I derived considerable amusement from reading his article on the above subject, especially the last paragraph but one. I consider I pos ess a certain amount of imagination (what model engineer doesn't?) and the thought o "clocking on" for an hour or two in the garden shed and dropping the nimble "bob" in the slot proved too much for me. It is fairly safe to say that a good 70 per cent. of model engineers in the aforementioned garden shed are "bunged up"—perhaps a car has to be got in, or a couple of bikes, garden tools—or perhaps other bits the wife bungs in when you aren't looking. Well, assuming that the sides of the "ole shed" would stand up to the weight of his 3 ft. $\times$ 2 ft. Lots Road control box I reckon something would have to be "chucked out" on to the lawn. Once again, no offence to Mr. Blackhurst, I just couldn't help it, it tickled me so. Seriously though, why so big? The model engineer can work only one machine at a time (unless he has half his neighbours in to step up production) and surely he doesn't leave them all running. We'll take his heaviest load on his lathe, say, $\frac{1}{2}$ h.p. motor. On peak surges (say when his parting tool digs in) give it 1,000 watts, about 5 amps., and that's plenty—and he's got 20-amp. fuses! If he blows them I'll bet his neighbours think he's making atom bombs—there I go again—sorry!

Yours faithfully,
Windsor. W. R. FIELD.

Inaccurately Cut Ratchet Wheels

DEAR SIR,—Trouble with these can be overcome by using double pawls arranged side by side on the same stud; or if the wheel is too narrow, one behind the other. One must be half a tooth shorter than the other. This allows a finer adjustment, as half a tooth can be taken, the load coming alternately on first one pawl then the other, thus in effect doubling the number of teeth on the wheel.

This device has been in use for many years on certain American printing machines and, I believe, on certain precision grinding machinery.

Yours faithfully,
London, N.22. W. ADDISON.

Contribution to the Kitchen Front—Kitchen Mixer

DEAR SIR,—My article under the above heading in your issue of August 10th last seems to have attracted some interest and I have received a number of enquiries as to where the motor was obtained.

Unfortunately, Mr. K. W. Logan, of Hitchin, from whom I purchased mine, has now sold out and I do not know of any other source of supply.

The motor is, of course, *ex*-service and its proper name is, I understand, a 3-in. "Magslip" receiver.

If any of your readers have been able to find a supplier elsewhere and would let me know, I would undertake to pass the information on to my enquirers.

Yours faithfully,
Goring-by-Sea. J. A. PILKINGTON.

Barronia Metal

In the issue of THE MODEL ENGINEER dated September 14th, a practical letter by Mr. H. Bristow was published referring to this copper alloy, giving the address of the manufacturers. We are informed, however, by readers who have written to this address that the firm has gone away. We should be glad to hear either from the firm concerned or from anyone who knows of their present address.—ED., "M.E."